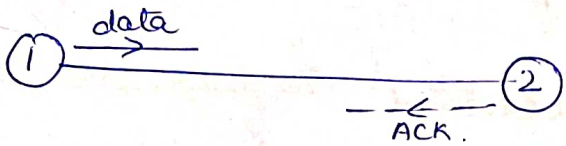
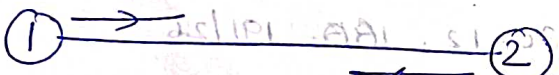
BASIC CONCEPTS OF N/W

: Simplex transmission.



: Half duplex transmission.

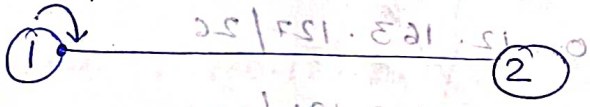
eg. walkie-talkie.



: full-duplex transmission.

Both System are transmitting the data at same time.

eg. Mobile.



T.T = transmission time.

⇓

Time taken to place the data on the cable by the system (i.e. port)

$$T.T. = \frac{\text{Data Size}}{\text{Bandwidth}} = \frac{\text{bits}}{\text{bits/sec}} = \text{sec.}$$

⇒ The time taken to place the data on the n/w is known as 'transmission time'.

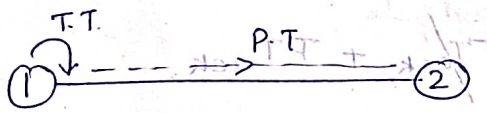
⇒ Maximum capacity of the link (cable) is known as 'Bandwidth'.

eg Data size = 2 K bits.

B.W. = 10 Mbps.

$$T.T = \frac{2 \times 10^3}{10 \times 10^6} = \frac{10^3}{10^3} = 0.2 \text{ msec} = 200 \mu\text{sec}.$$ Ans.

⇒ "Transmission time is the property of computer."

① 

P.T. = Propagation time

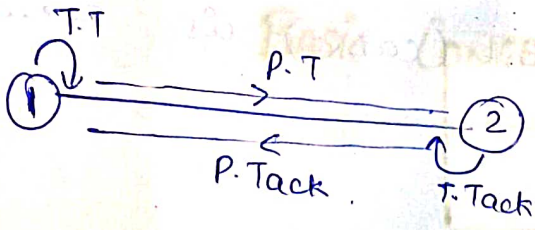
$$P.T. = \frac{\text{distance}}{\text{velocity of medium (cable)}}$$

⇒ Propagation time doesn't depend on data size.

eg: D = 2 Km.

$v = 2 \times 10^8$ m/sec.

$$P.T = \frac{2 \times 10^3}{2 \times 10^8} = 10^{-5} = 10 \mu\text{sec}.$$



ACK size <<<< Data size..

$$T.T_{ack} = \frac{\text{ACK size}}{Bw.}$$

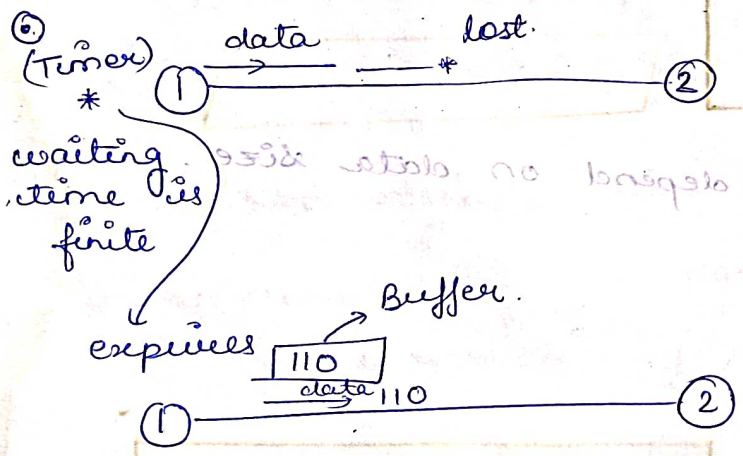
$\boxed{T.T_{ack} = \text{negligible}}$.

$\boxed{P.T._{data} = P.T._{ack}}$

Total time = $TT_{data} + PT_{data} + \cancel{T.T_{ack}}^{\text{negligible}} + PT_{ack}$.

$\boxed{\text{Total time} = TT + 2PT.}$

If waiting time = ∞
$\Updownarrow$
u are not waiting at all.



⇒ Since waiting time is finite, a timer is reqd. whenever the data is transfer.

⇒ Inorder to retransmitt the data whenever the data is lost, a buffer is reqd.

⊙ Link Utilization of Sender $= \frac{T.T}{TT + 2 * PT.}$

⊙ $\% LU = \frac{TT}{TT + 2PT} * 100.$

eg. $\left\{ \begin{array}{l} LU = 50\% \\ TT = 2PT. \end{array} \right\}$

$$\frac{50}{100} = \frac{TT}{TT + 2PT} * 100$$

$$\frac{50}{100} = \frac{TT}{TT + 2PT.}$$

$$2TT = TT + 2PT$$

$$TT = 2PT.$$

eg. $LU = 50\%$
$d = 2km$
$v = 2 \times 10^8 m/sec$
$B.W. = 10Mbps$
Data Size = ?

$$\frac{DS}{BW} = \frac{2 \times d}{v}$$

$$\frac{DS}{10 \times 10^6} = \frac{2 \times 2 \times 10^3}{2 \times 10^8}$$

$DS = 200$ bits

Quesⁿ: $B.W. = 100Mbps.$
Calculate 1 bit delay.

$1 sec \longrightarrow 100 \times 10^6$ bits

$1 bit \longrightarrow \frac{1}{10^8}$ sec

$1 bit \longrightarrow 10^{-8} sec \Rightarrow \frac{10^{-1} \times 10^{-8}}{10^{-1}}, \frac{10 n sec}{10}$ Ans.

$= 0.01 \mu sec$ Ans.

(OR) $TT = \frac{DS}{BW} = \frac{1}{10^8} = 10^{-8} = 0.01 \mu sec$

Ques^n : B.W. = 100Mbps.

$v = 2 * 10^8$ m/sec.

Calculate 1 bit delay in meters of cable.

1 sec $\longrightarrow$ 100×10^6 bit.

1 bit delay $\longrightarrow$ 0.01μ sec. $= 10^{-8}$ sec

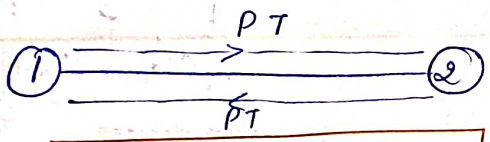
1 sec $\longrightarrow$ 2×10^8 m.

~~1 m~~ $\longrightarrow$ ~~$\frac{1}{2 \times 10}$~~

10^{-8} sec $\longrightarrow$ $2 \times 10^8 \times 10^{-8}$ m

$\longrightarrow$ 2m. } Ans.

(6)



R.T.T. = 2 * PT.

Round Trip Time.

$\Downarrow$

Characteristics / property of link.

Ques^n : B.W. = 100Mbps.

RTT = 50msec

Calculate # bits in R-T-T. $\Rightarrow$ 5000 bits.

1 sec $\longrightarrow$ 100×10^6 bits.

50msec $\longrightarrow$ $100 \times 10^6 \times 50 \times 10^{-6}$ bits

$\longrightarrow$ 5000 bits. Ans.

Ques^n: B.W. = 10 Mbps.

R.TT = 40 μsec.

DS = 20 bits.

Calculate # data units in R.T.T.

1 sec ⟶ 10×10^6 bits.

40 μsec ⟶ $10 \times 10^6 \times 40 \times 10^{-6}$

⟶ 400 bits.

$\Rightarrow \frac{400}{20} = 20$ bits. Ans

⊙ **Throughput :** The rate at which user transmits the data is known as throughput.

↳ like bps

$$\text{Throughput} = \frac{\text{Data size}}{TT + 2 * PT}$$

⊙ Downloading a video file.
file size = large
Th = large

⊙ Downloading a text file
file size = small
Th = small

Ques^n: DS = 100 bits.

B.W = 10 Mbps.

$d = 2003$ km.

$v = 2.3 \times 10^8$ m/sec

$TT = \frac{100}{10 \times 10^6} \Rightarrow \frac{10^2}{10^7} = 10$ μsec

$PT = \frac{2003 \times 10^3}{2.3 \times 10^8} \Rightarrow 10^{-5} = 10$ μsec.

$TH = \frac{100 \text{ bits}}{10 \mu sec + 20 \mu sec}$ $\frac{100 \text{ bits}}{30 \mu sec} \Rightarrow \frac{100}{30}$ Mbps.

$\Rightarrow 3.33$ Mbps. Ans.

$U = \frac{TT}{TT + 2PT} = \frac{10 \mu sec}{30 \mu sec} = \frac{10}{30} \times 100 \Rightarrow \frac{100}{3} \Rightarrow 33.3\%$ Ans

⊙ $LU = \frac{TT}{TT + 2PT}$

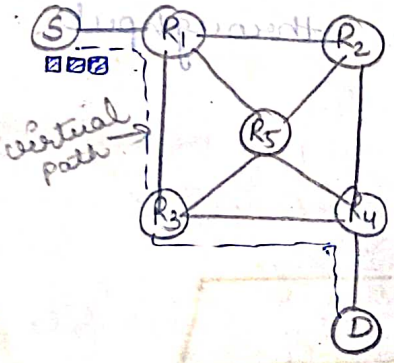
$LU = \frac{\frac{DS}{BW}}{TT + 2 * PT}$

$LU = \frac{\text{throughput}}{B.W.}$

Circuit Switching & Packet Switching

Data is broken into small pieces of variable length called packet.

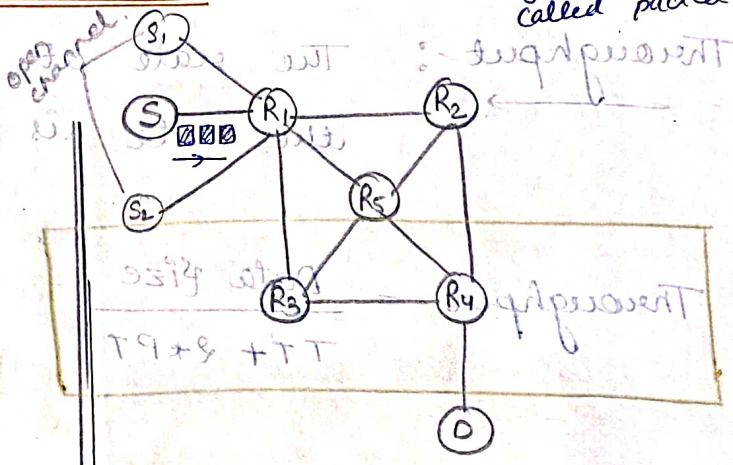
⊙



① 3 phases are there :-
i) Connⁿ establishment (sec)
ii) Data transfer (nsec/μsec)
iii) Connⁿ release. (sec)

② In ckt switching, each data unit will have entire path address

⑥ Used in telephone n/w for bidirectional, real time transfer b/w computers.



① Only 1 phase :-
(ii) Data transfer. (μsec).

② In packet switching, each data unit will have destination address. The intermediate path is decided by the router.

⑥ Used to optimize the use of the channel capacity available in a n/w, to minimize the transmission latency & robustness of comm.

③ It is not a stored & forward technique, because the packets are not giving the chance for the routers to show the path.

④ Pack The transmission of packets will be done by the source, so overall processing time is low.

⑤ Resource reservation is a feature of ckt switching because entire bandwidth is dedicated to a user at that time.

⑥ Wastage of resources will be more in ckt switching.

⑦ Congestion can occur during conn^n establishment.

⑧ It is not a fault tolerant technique because data cannot be diverted via alternate paths.

③ It is a store & forward technique because the router stores the packet, algo is applied & then forwarded on the best path.

④ The transmission of the packets is done not only by source but also by intermediate routers so processing time will be high.

⑤ Resource reservation is not required because packets are shared among the users.

⑥ Wastage of resources will be less in packet switching because resources are shared

⑦ Congestion will occur during data transfer phase

⑧ It is a fault tolerant technique because it can be diverted via alternate paths.

(9.) It is reliable.	(9.) It is unreliable.
(10.) It is used for long message.	(10.) It is used for short messages.
(11.) It is slow.	(11.) It is fast.
(12.) Delay b/w data units = uniform	(12.) Delay b/w data units = variable non-uniform

TOPOLOGIES (LAN structure)

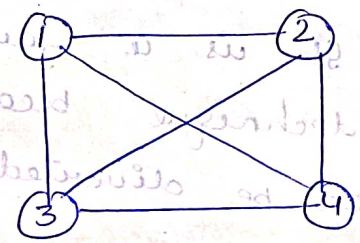
Arrangement of n/w which comprises of nodes & connecting lines via sender & receiver is referred as topology.

- Physical topologies
  - Mesh topology.
  - Star topology.
  - Bus topology.
  - Ring topology.
- Logical topologies
  - IEEE 802.3.
  - IEEE 802.5.

⇒ 'Physical topology' deals with how physically the system's is connected with the cables.

⇒ 'Logical topologies' will give an idea how the data is transmitted in the LAN n/w.

(1.) MESH TOPOLOGY:-



⊙ 4 devices, 6 links are used.

n devices, $^nC_2 = \frac{n(n-1)}{2}$ links.

2 ⇒ 1 Cable is connected with 2 devices.

⊙ 4 devices, each device requires 3 ports.

n devices, each device requires (n-1) ports.

⊙ eg: 100 computers, $\frac{100 \times 99}{2}$ cables | = 4950 links.

⊙ Drawbacks: a) cost is high

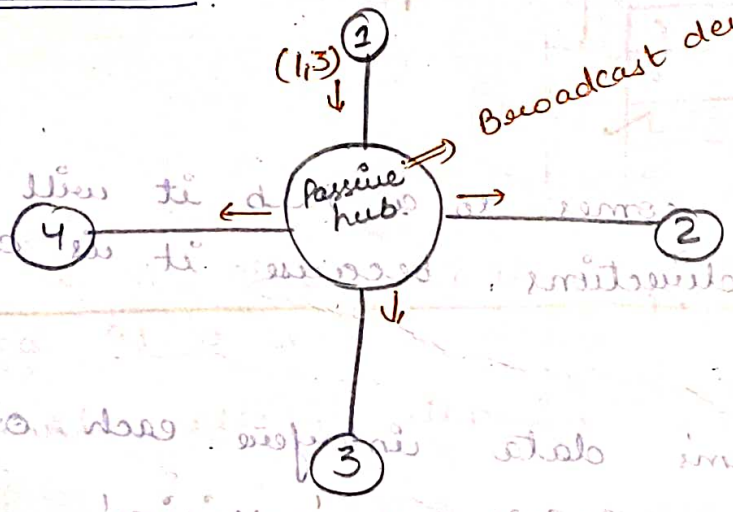
b) maintenance difficulties.

Out of 4950 links, 1 link is failed, identifying failed link is difficult.

⊙ Advantage: reliable & secure.

⊙ Used for small group (or) project.

(2.) STAR TOPOLOGY:



⊙ In star topology, every system is connected to a centric device, (i.e. hub).

⊙ 4 devices, 4 links are reqd.

n devices, n links are reqd.

eg. 100 devices, 100 links are reqd.

⊙ Advantage: a) Cost is less

b) For Each device requires 1 port.

⊙ Browsing centre.

⊙ Passive = Non-intelligent device.

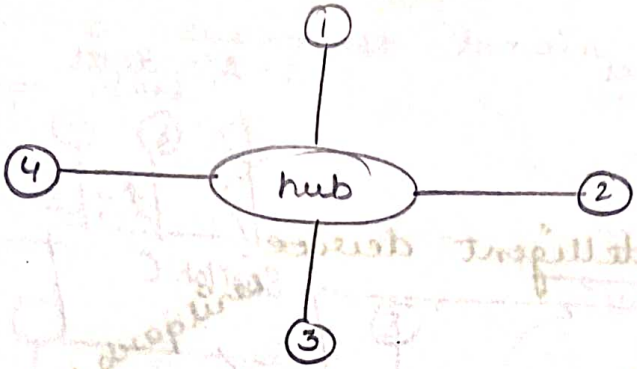
⊙ Device

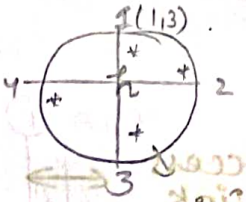
- Active Device (or) Intelligent Device.
  - All are switch.
  - eg: Bridge, router, switch, Gateway.
  - ⇓ have table
  - ⇓ Make decisions whether to block (or) forward the data.
- Passive Device (or) Non-intelligent Device.
  - eg: Hub, Repeater.
  - ⇓ No table.
  - ⇓ Simply forwards the data.

⊙ Whenever a packet comes to a hub it will be diverted in all directions because it is a broadcast device.

⊙ 2 (or) more systems data interfere each other then there is a possibility of 'collision'.

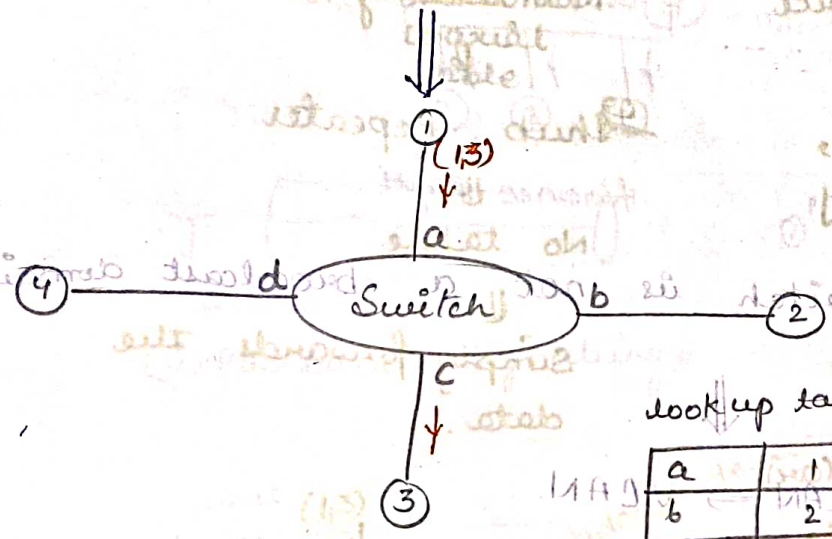
⊙ The place (or) area where collisions occur is known as 'collision domain'.

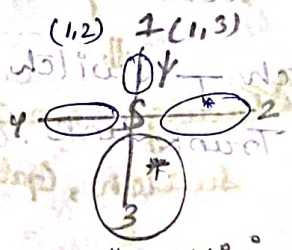




collision domain = 1

⊙ Hub is not a collision domain separator, i.e. if hub is used as centric device then entire n/w has a same collision domain.





collision domain = 4.

look up table

a	1
b	2
c	3
d	4

⊙ Switch is a collision domain separator, i.e. if switch is used as a centric device then each port has a separate collision domain.

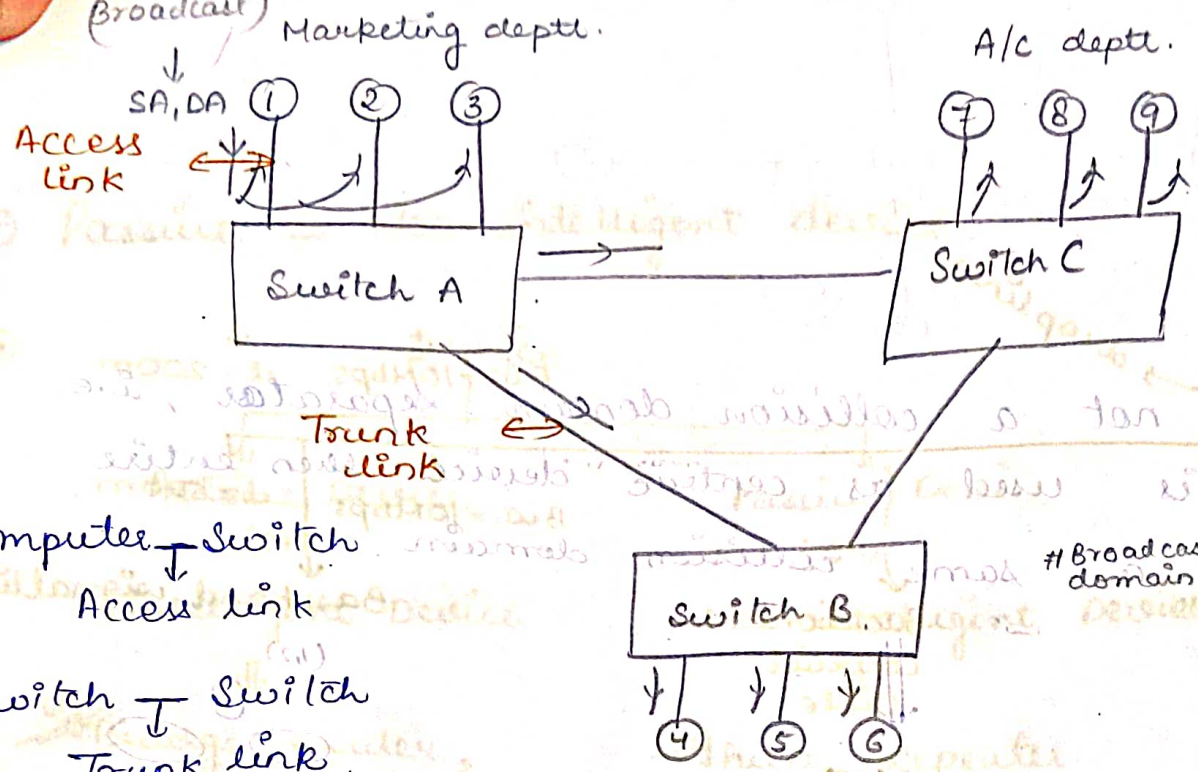
⊙ Bridge, router & Gateway ⇒ all are switch.

① A basic or simple switch is a bridge.

② Both bridge and computer will have MAC address.

⊙ If data is transmitted to all computers is known as 'broadcast'.

⊙ The place (or) area where broadcast has been done is known as 'broadcast domain'.



Computer ⊤ Switch
↓
Access link

Switch ⊤ Switch
↓
Trunk link.

⊙ By default, switch is not a broadcast domain separator.

⇓

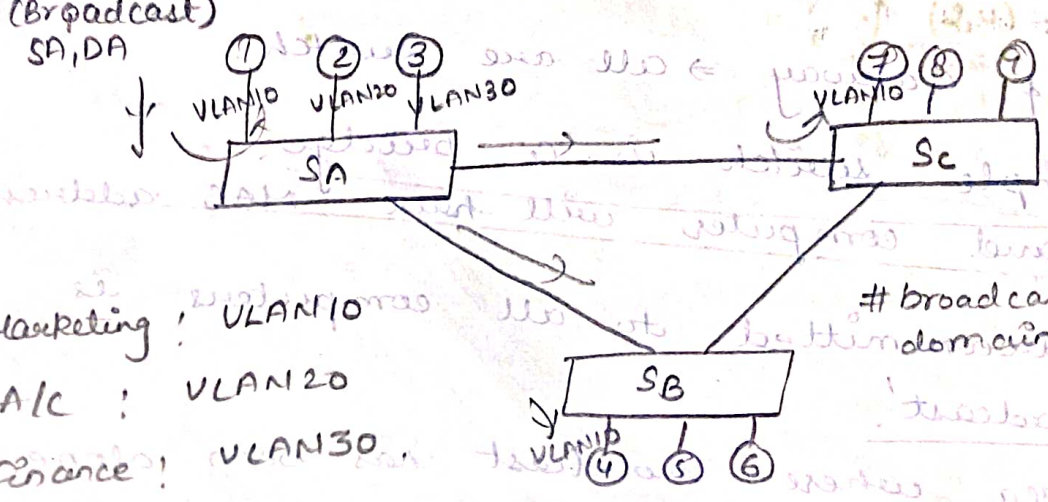
LAN ⟹ VLAN.

⇓

(By configuring the ports of switch)

VLAN :-

⊙ Physically, the system can be place anywhere but they have logically connected belonging to a grp.



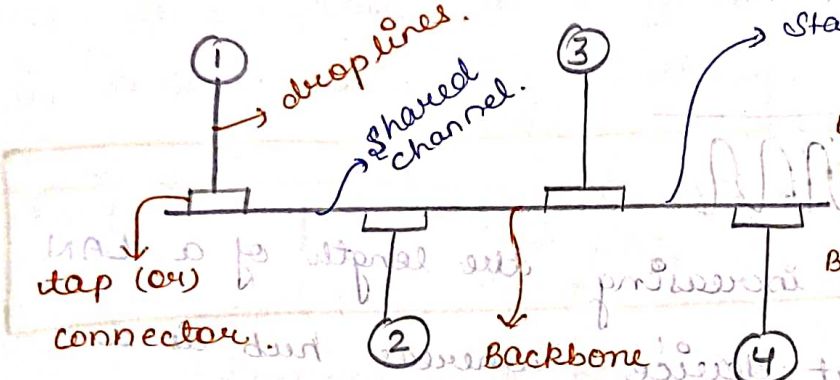
Marketing : VLAN10

A/c : VLAN20

finance : VLAN30.

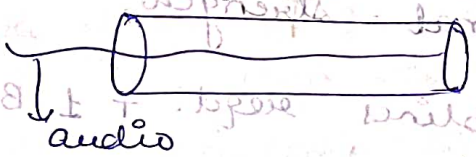
⑤ Switch is a broadcast domain separator by converting LAN into VLAN.

③ BUS TOPOLOGY :



① In which every comp. & n/w device is connected to a single cable. It transmits the data from 1 end to another in a single line.

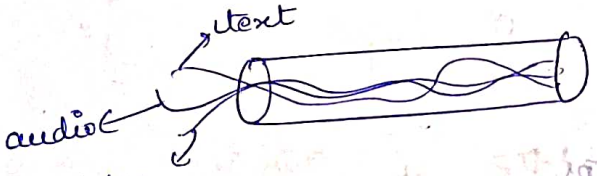
(i) Baseband signalling.



Adv:
1) Cost = less
2) N devices
N drop(s)
1 cable.

Disadv:
1) If common cable fails, whole sys will cost down.

(ii) Broadband signalling.



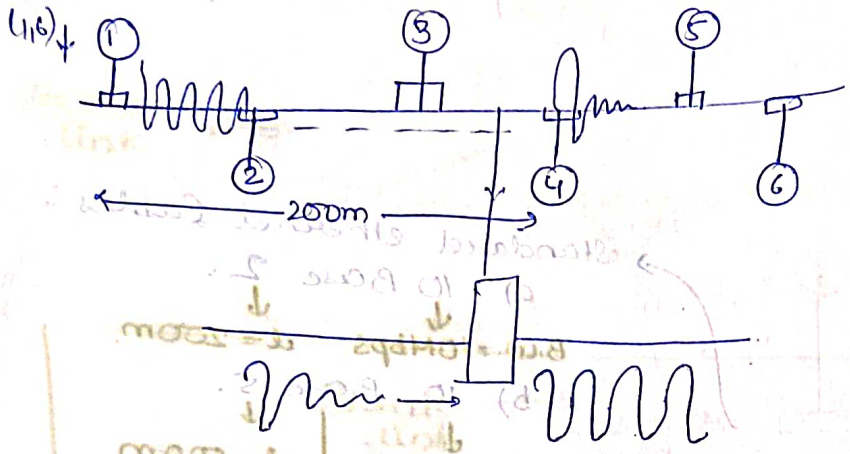
⇓

More than 1 type of data is transferred at same time, so B.W = large.

① If only 1 type of data is allowed at a time, it is known as baseband signalling.

① If more than 1 type of data is allowed is known as broadband signalling.

Q. 10 base 2



⊙ Amplifier increases the strength of a signal.

⊙ Repeater is used for increasing the length of a LAN

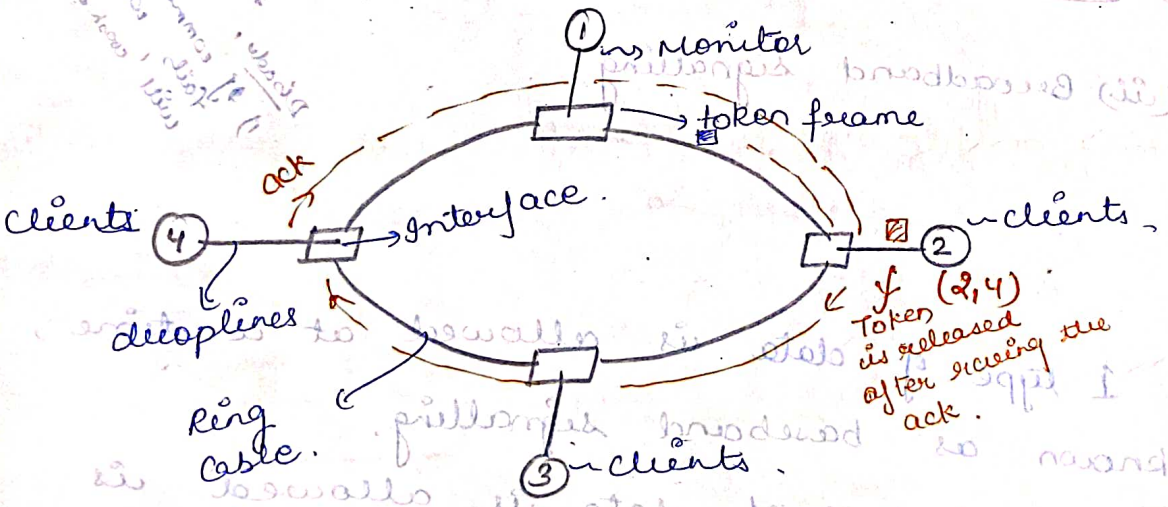
⊙ Repeater is a 2-port device whereas hub is multiport device.

⊙ Repeater is a regenerative device, because it regenerates the signal to its original strength.

⊙ n device ⇒ n duoplines reqd. + 1 Backbone Cable.

⊙ Advantage: Cost is less.

(4) RING TOPOLOGY:



⊙ Monitor is responsible for proper opⁿ of the ring.

⊙ Monitor inserts token frame so that it can be utilized by stations for transmitting a data

If no stat^n is having a data the token will simply circulating in the ring.

⊙ 'n' devices = 'n' droplines + '1' ring cable.

ⓘ The time taken to complete 1 rotation of a ring is known as ring latency.

Ring latency = Propagation delay of ring + Interface delay.

#Stations = # interfaces

13th July'15 [Monday]

Ques^n: length of the ring = 2300 m.

$v = 2.3 \times 10^8$ m/sec.

#Stations = 50

each (station)' interface has 1 bit delay.

B.W = 10Mbps.

RL = ?

1 sec → 10M bits

1 bit → $\frac{1}{10 \times 10^6}$

$\frac{50 \text{ bits}}{10 \times 10^6 \text{ bits/sec}}$

$RL = \frac{2300}{2/3 \times 10^8} + 50 \mu sec$

$\Rightarrow 1 \mu sec + 50 \mu sec$

RL $\Rightarrow$ 6 μ sec. Ans.

Ques^n 2: $l = 2000$m

$v = 2 \times 10^8$ m/sec

B.W. = 100 Mbps.

#Stations = 25.

each interface has 1-bit delay.

RL = ? in terms of bits.

R.L. =

$$Pd = \frac{10^3 \text{ m}}{2 \times 10^8 \text{ m/sec}}$$

$$\Rightarrow 10^{-5} \text{ sec}.$$

$1 \text{ sec} \longrightarrow 100 \times 10^6$ bits.

$10^{-5} \text{ sec} \longrightarrow 10^{-5} \times 10^2 \times 10^6$ bits

$10^{6-5} \times 10^2$ bits.

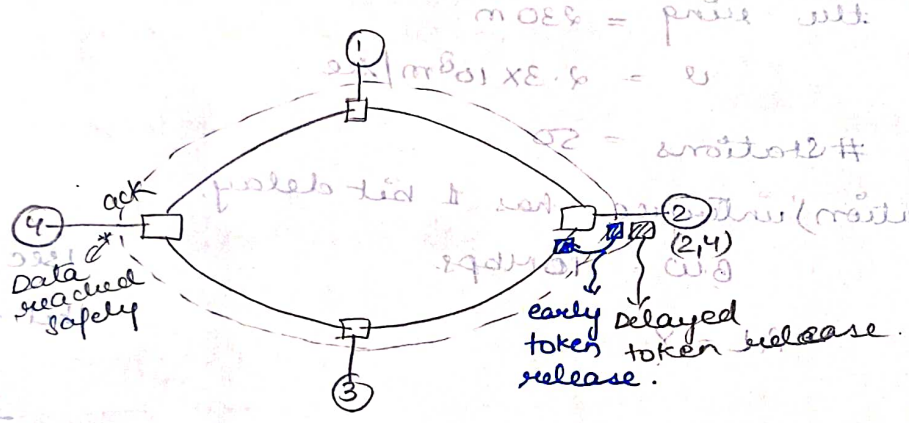
10×100 bits

1000 bits.

$\Rightarrow$ 1000 + 25 * 1 bits

$\Rightarrow$ 1025 Ans

*



- If token is released after getting the ack., it is called as delayed token release.
- If token is released just after transmitting the data, it is known as early token release.
- In terms of reliability, delayed token release is better than early token release.
- In terms of utilization, early token release is better than delayed token release.

⇓

on same time, more no. of people can transmit the data coz token is release only after ... the data

% Utilization of delayed token release $= \frac{T.T}{TT + R.L + \frac{R.L}{N}} \times 100\%$.

% Utilization of early token release $= \frac{T.T}{T.T + \frac{RL}{N}} \times 100\%$

$RL = 100\mu sec$

$N = 25$

$T.T = 10\mu sec$.

% utilizatn of delayed token release $= \frac{10\mu sec}{10\mu sec + 100\mu sec + \frac{100\mu sec}{25}}$

$= \frac{10\mu sec}{114\mu sec}$.

% utilizatn of early token release $= \frac{10\mu sec}{10\mu sec + 4\mu sec}$

$= \frac{10\mu sec}{14\mu sec}$.

Advantage:
1) Possibility of collision is min.
2) Cheap to install & expand.

Disadv:
1) Addition of stn or removal of stn in b/w can disturb the whole topology.

OSI MODEL

Data

		Device	Addr.
Message	Appln Layer		Appln Layer
	Presentation Layer		
	Session Layer		
(TCP) Segment / (UDP) Datagram	Transport Layer	All layered switch. Gateway	Port addr.
Packets	N/w Layer	3-layer switch. Router (internet / WAN device)	IP addr.
frames	Data link Layer	2-layer switch. Bridge (LAN device)	MAC addr.
bits	Physical Layer	hub + Repeater	Physical Layer.

(Head of OSI)

① Data link layer is responsible for node to node delivery within the LAN.

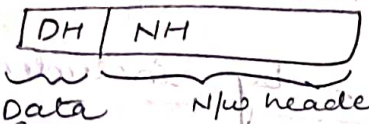
② N/w layer is responsible for source to destn delivery b/w diff. n/w's. {WAN ⇒ internet}

③ Transport layer is responsible for process to process delivery (or) end to end delivery.

④ A n/w architecture is known as protocol stack architecture because the tang last header i.e. added at the sender's side is the 1st header i.e. remove at the receiver side.

Ques: Does packet encapsulate frame or frame encapsulate packet?

Ans. frame encapsulates packet. { lower layer always encapsulates the upper layer }



Ques: If 'M' is a msg that should be transmitted & 'H' is a header i.e. added at every layer. 'N' layers is present in hierarchy then calculate the fraction of data in the whole content is transmitted.

Ans: # layers = N.

= HN (headers added)

Ans = $\frac{M}{M+HN}$ ∵ whole content is transmitted.

⇒ fraction of headers = $\frac{NH}{M+NH}$.

→ Functionalities:

Appl^n Layer: appl^n services like http, SMTP, FTP, DNS, etc --

Presentat^n Layer: Syntax (rules) & semantics (meaning) of data.

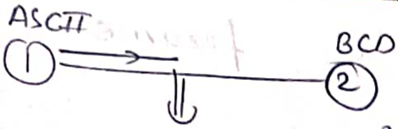
Session layer: dialog ctl & session management.

Transport layer: flow ctl, error ctl, segmentation, congestion ^ global policies.

N/w layer: fragmentation, traffic shaping, routing.

Datalink layer: ^ local flow ctl, error ctl, access ctl, MAC protocols

Physical layer: physical, electrical char of cable.



This conversion take care by presentatn layer.

⊙ 7 layers of OSI model has been reduced to 5 layers of TCP/IP model - by including the functionalities of presentatn & session layer in the appln layer.

<u>error ctrl</u> :- noise (modifies the data)

⇒ This seq. 2 should understands in a modified data so that error ctrl policies is applied.

⇓

1) error corrn → Hamming code.
2) error detectn → Parity
 → CRC
 → Checksum.

⊙ Transport layer provides global flow & error ctrl whereas data link layer provides local flow of error control.

<u>DATA LINK LAYER</u>

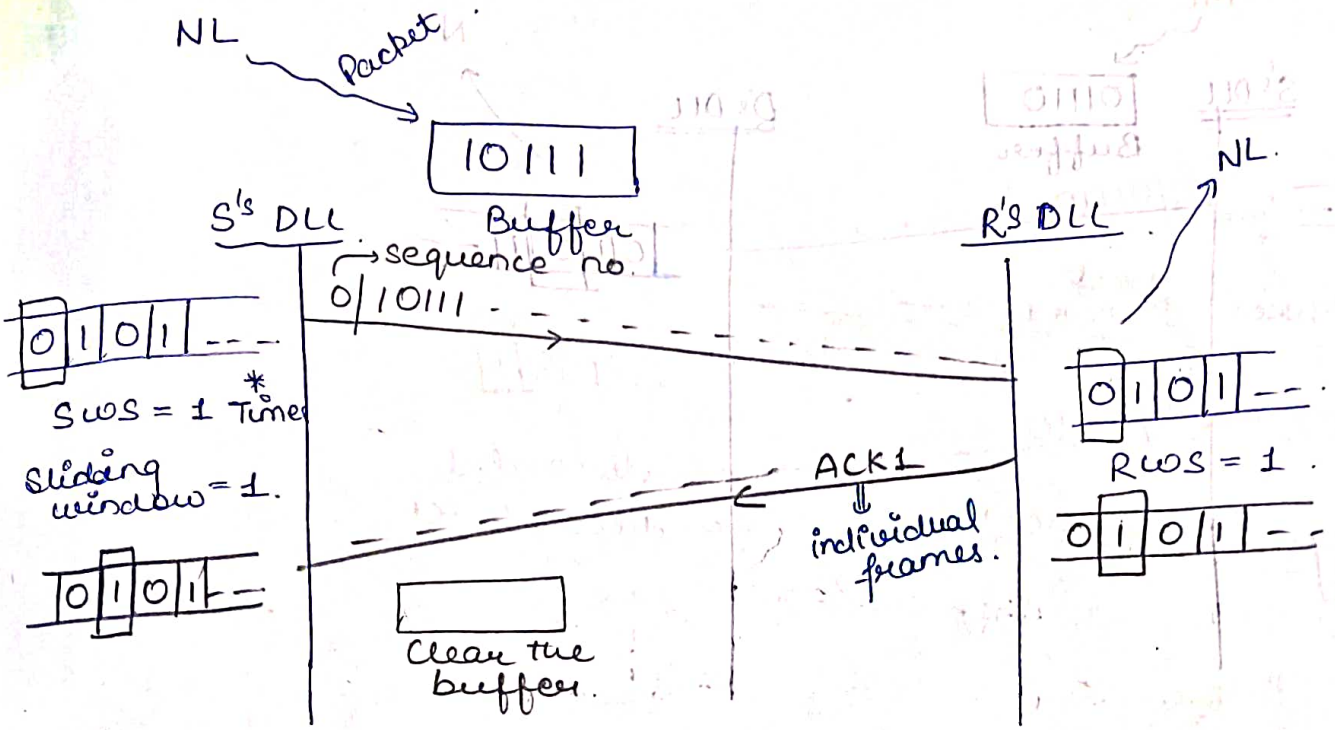
1) <u>Sequence no.</u> :
→ The protocol specifies that frames need to be numbered. This is done by using seq. no.
→ A field is added to the data frame to hold the seq. no. of that frame.
→ The seq. no. are based on modulo-2. arithmetic.

➡ <u>Flow Control policies</u> :

① <u>Stop & wait ARQ</u> :
↳ Automatic Repeat Request (No user involvement).

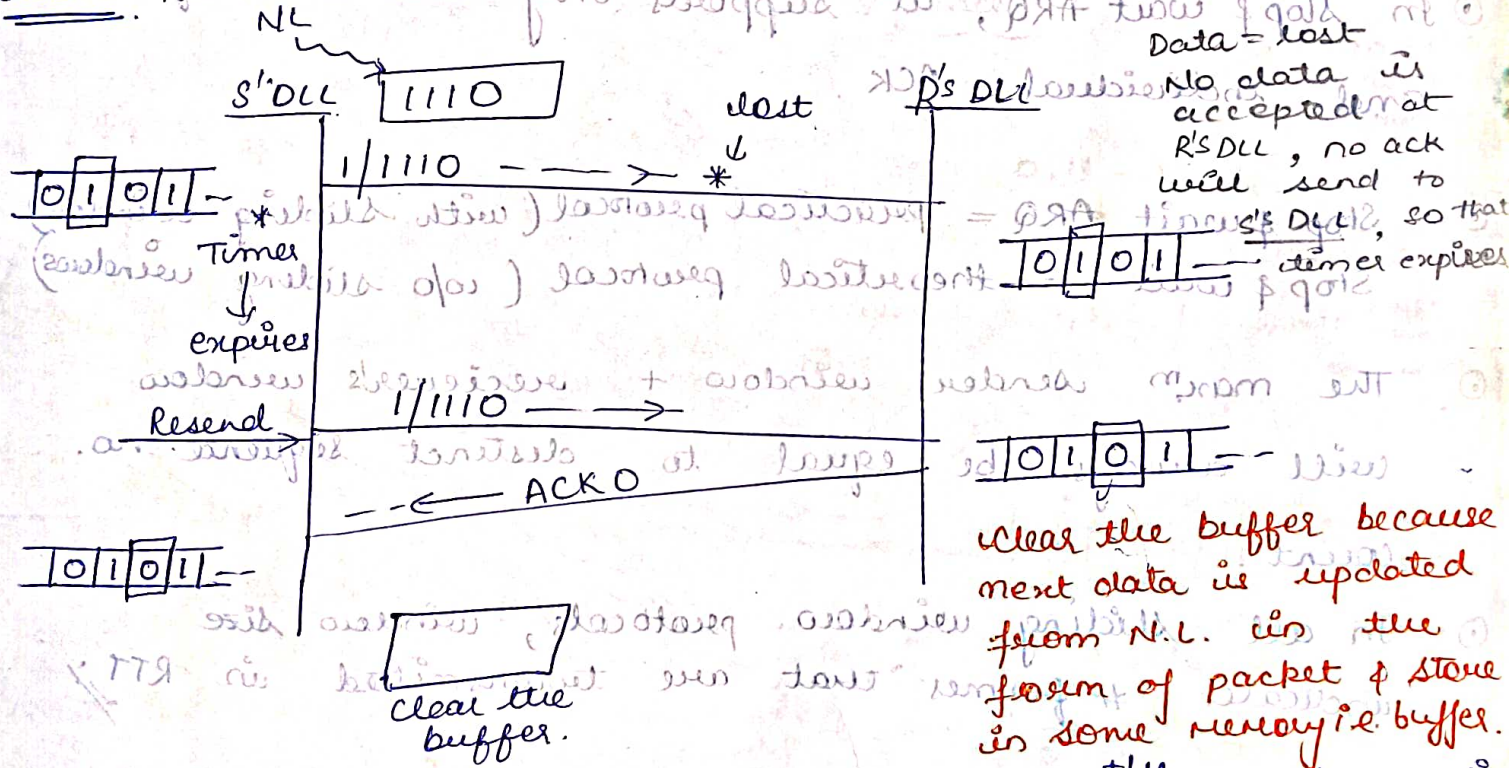
<u>Case 1</u> :

⊙ Once the data is reached to the destn, the sequence no. of the data is compared with receiver sliding window no. if both are matched, data is accepted and receiver window will slide by 1-bit.



⊙ ACK no. will always be the sequence no. of the next expected frame then only ACK is accepted otherwise it is discarded.

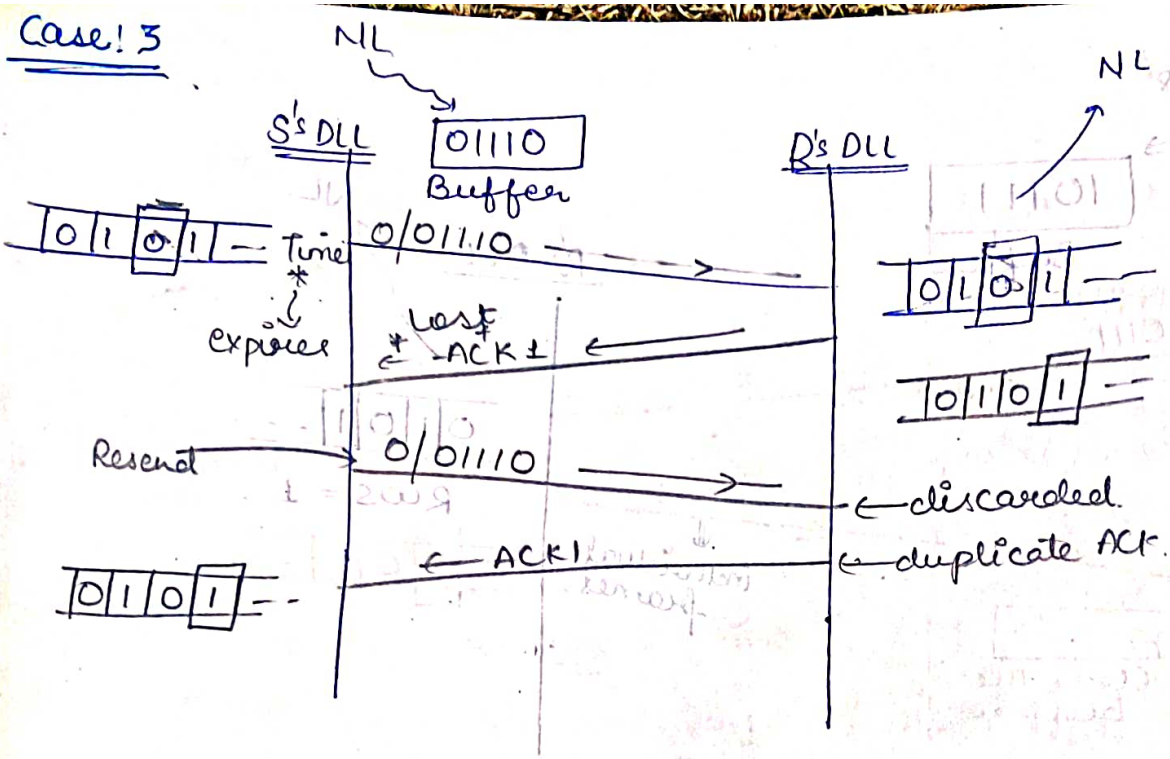
Case 2: Protocol resend the data if data = lost.



Clear the buffer because next data is updated from N.L. in the form of packet & store in some memory i.e. buffer.

⊙ Whenever the data is lost automatically the protocol resending the data and the ACK is accepted by the sender.

Case! 3



⇒ Stop & wait ARQ:

- Stop: after transmitting the data you stop
- wait: wait for ACK
- ARQ: Protocol resend the data if data = lost.

⊙ In Stop & wait ARQ, it supports only individual frames and individual ACK.

⊙ Stop & wait ARQ = practical protocol (with sliding windows)
Stop & wait = theoretical protocol (w/o sliding windows)

⊙ The max^m sender window + reciever's window will always be equal to distinct sequence no.

⊙ In all sliding window protocols, window size indicates # frames that are transmitted in RTT.

⊙ Drawback: a) Bandwidth utilization of the channel is less.

b) There is no pipelining in stop & wait ARQ so utilization is less.

Ques:! B.W = 100 Mbps

RTT = 50 msec.

frame size = 50 bits.

1 sec ⟶ 100×10^6 bits.

50 msec ⟶ $100 \times 10^6 \times 50 \times 10^{-6}$ bits

5000 bits

bits possible in RTT = 5000

frames in RTT = $\frac{5000}{50} = \underline{100}$

∴ BW utilization (only 1 frame in RTT) = $\frac{1}{100} \times 100$

(Stop & wait ARQ) = 1 % = Less

② GO BACK N ARQ:

Sequence bits

2

Sequence no.

0, 1

00
01
10
11

0, 1, 2, 3

S_f = where does the window is starting.

S_n = addr. of next window started.

0, 1, 2, 3, 4, 5, 6, 7

$S_f = S_n$ (All frames are sends)

Case-1:

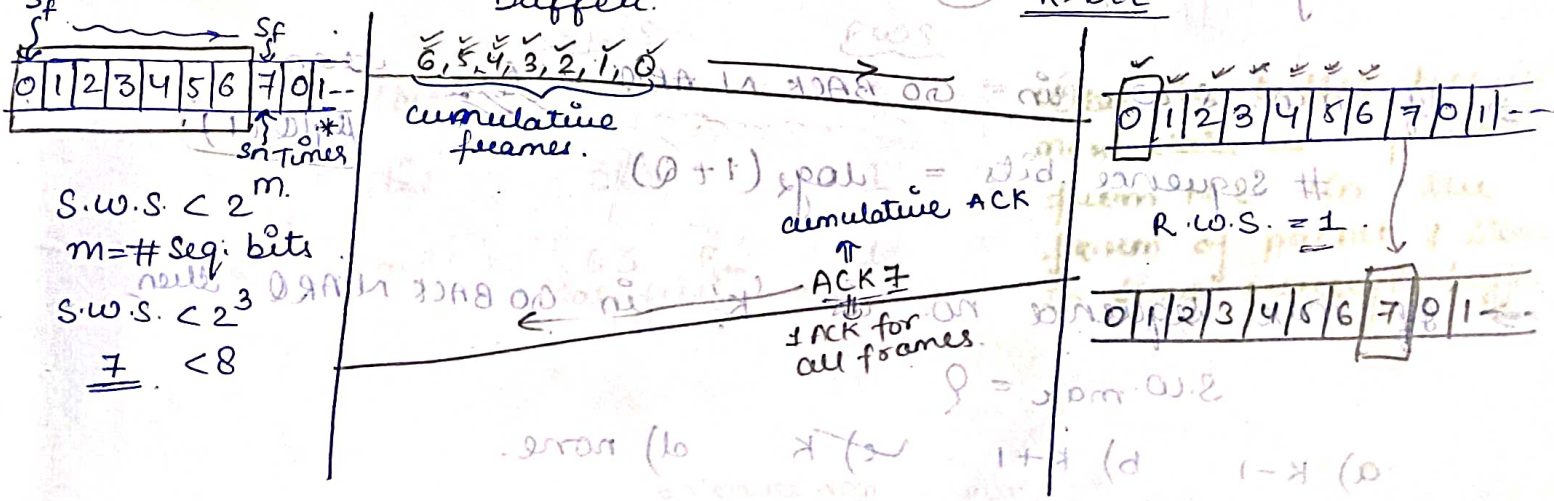
NL. 3

S's DLL

Buffer

expects more no. of packets.

R's DLL



S.W.S. $< 2^m$.

m = # Seq. bits

S.W.S. $< 2^3$

7 < 8

⊙ GO BACK N ARQ supports cumulative [illegible] ACK's.

⊙ GO BACK N ARQ supports pipelining so utilization is high.

Ques: If 4-bit sequence no. is used. what is the max SWS & RWS in GO Back N ARQ

seq. no. $= 2^4 = 16$

$WS = 2^4 - 1 = 16 - 1 = 15$

$WR = 1$

$\Rightarrow S.W.S. < 2^m$

$< 2^4$

$15 < 16$

$R.W.S. = 1$

Ques: If max size of S.W = 7 then no. of sequence bits in GO BACK N ARQ. Ans 3

$WS = 7$

$WR = 1$

seq. no. $= 7+1 = 8 = 2^3$

bits in seq. no. $= 3$

~~$S.W.S. < 2^m$~~

$SWS_{max} = 2^m - 1$

$2^m = SWS_{max} + 1$

$\boxed{m = \log_2(SWS_{max} + 1)}$

$m = \log_2(7+1)$

$= \log_2 8 = \log_2 2^3 = 3$

⇒ If max. S.W. in GO BACK N ARQ = Q then

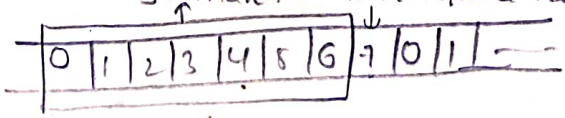
$\boxed{\log_2(Q+1)}$

Sequence bits $= \log_2(1+Q)$.

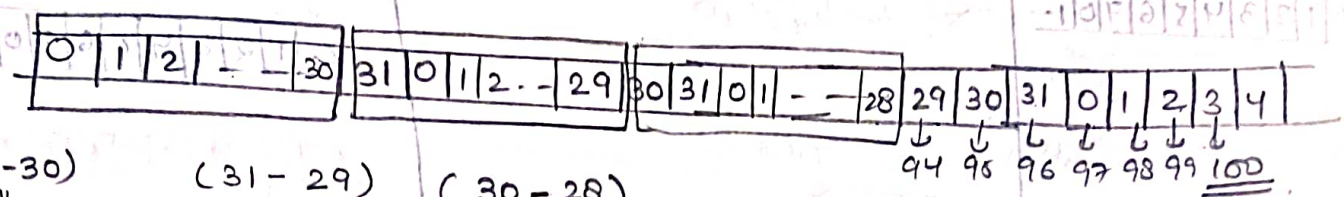
⇒ If max sequence no. is 'K' in GO BACK N ARQ then

S.W.max = ?

a) K-1 b) K+1 c) K d) none.



Ques: If 5 bit sequence no. is used, & initial sequence no. is '0'. what will be the sequence no. for 100 frames.



(0-30) ⇓ 31 frames ⇓

(31 - 29) ⇓ 31 frames.

(30 - 28) ⇓ 31 frames = 93 frames

for 93 frame = 28 is sequence no.

Ques: B.W. = 50 Mbps.

RTT = 10 μsec.

frame size = 10 bits

window size = ? #frames in RTT = 50 } Ans

sequence bits in GO BACK N ARQ = ? 6 bits

1 sec → 50×10^6 bits

10 μsec → $50 \times 10^6 \times 10 \times 10^{-6}$ bits

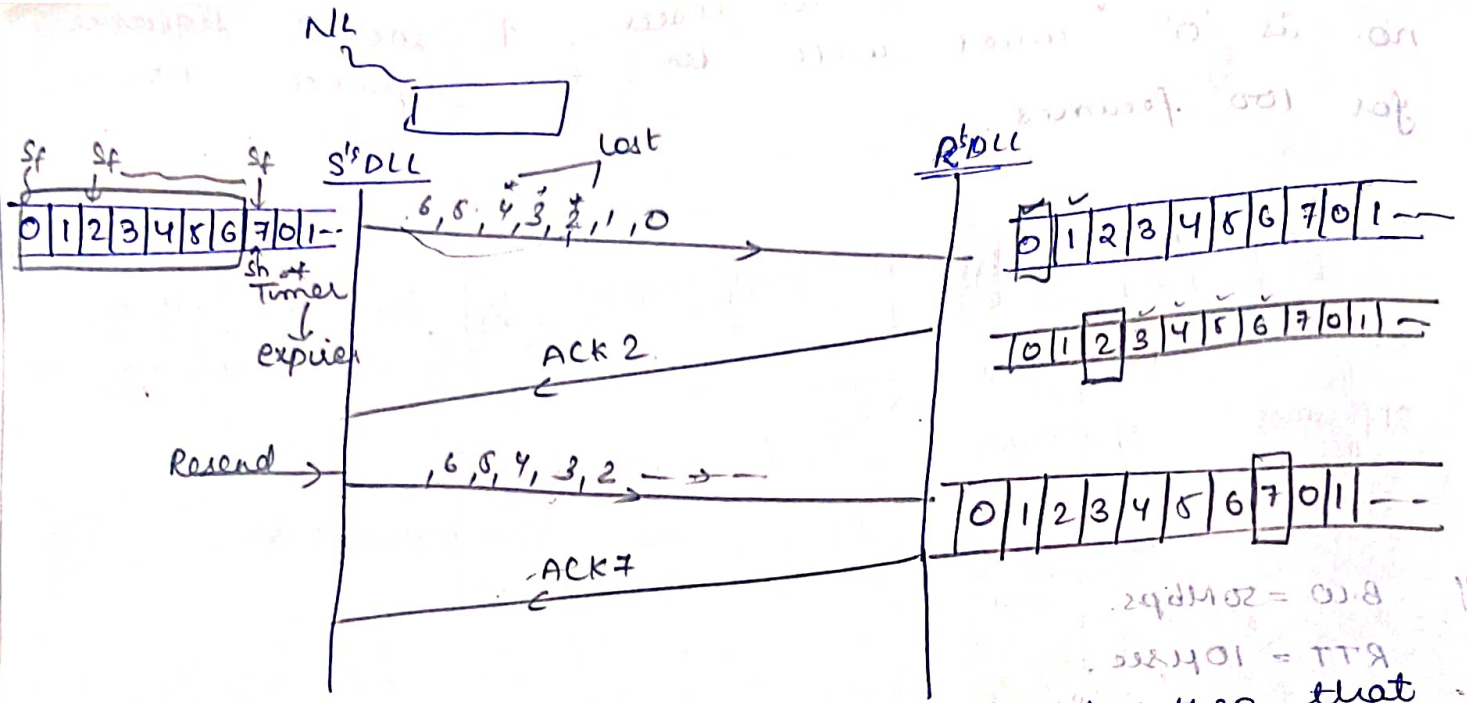
= 500 bits.

$\frac{500 \text{ bits}}{10 \text{ bits}}$

bits in RTT = 50

Sequence bits :- 6 bits.

	SWS	RWS
X 4 bit	15	1 = 16
X 5 bit	31	1 = 32
✓ 6 bit	63 (satisfies) 50	1 = 64.



⊙ In GO BACK N ARQ, if a frame is lost then that frame which is lost as well as all following frame should be re-transmitted.

⊙ 'Sf' will move to the position i.e. pointed by the ACK no.

⊙ If new packets are not available in the buffer then only the remaining old packet should be transmi

⊙ GO BACK N ARQ for noisy channel

6, 5, 4, 3, 2, 1 →

6, 5, 4, 3, 2 →

6, 5, 4 →

6, 5 →

6 →

⊙ In terms of η, Selective Repeat ARQ = GO Back N ARQ

⊙ In terms of retransmission, Stop & wait ARQ ≡ Selective Repeat ARQ.

⊙ Drawback! There are more no. of retransmission for noisy channel so overall utilization will be less.

⊙ Both the stop N wait ARQ & GO BACK N ARQ, supports inorder frames because R.WS. = 1.

Quesn! In GOBACK N ARQ, in sender condn. S.W.S. $< 2^m$ when $m = 1$, behaves like stop & wait ARQ.

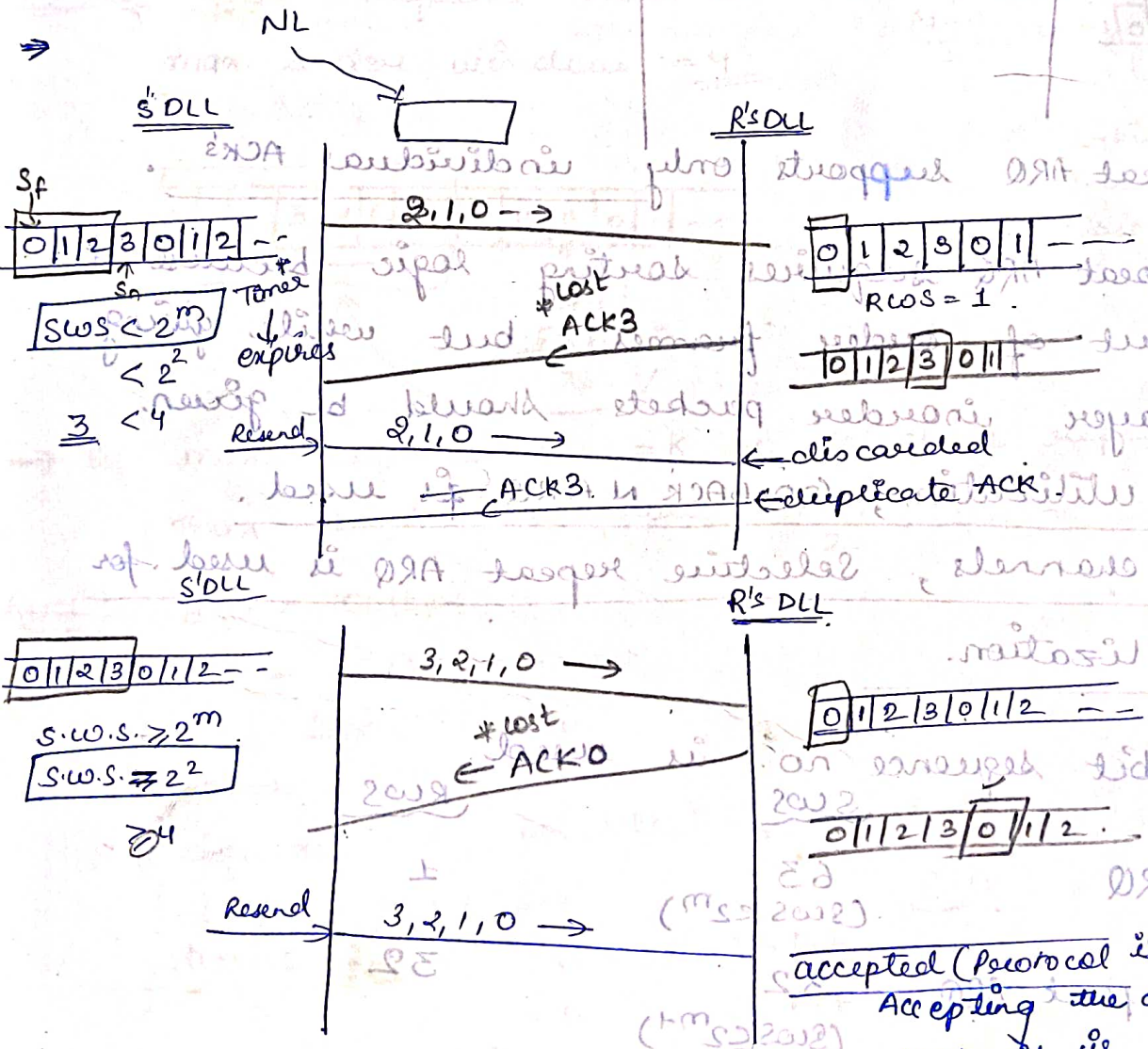
S.W.S. $< 2^1$

S.W.S. < 2.

S.W.S. = 1 { R.W.S. = 1 } ∴ stop N wait ARQ.

⊙ GOBACK N ARQ supports both cumulative ACK as well as individual ACK.

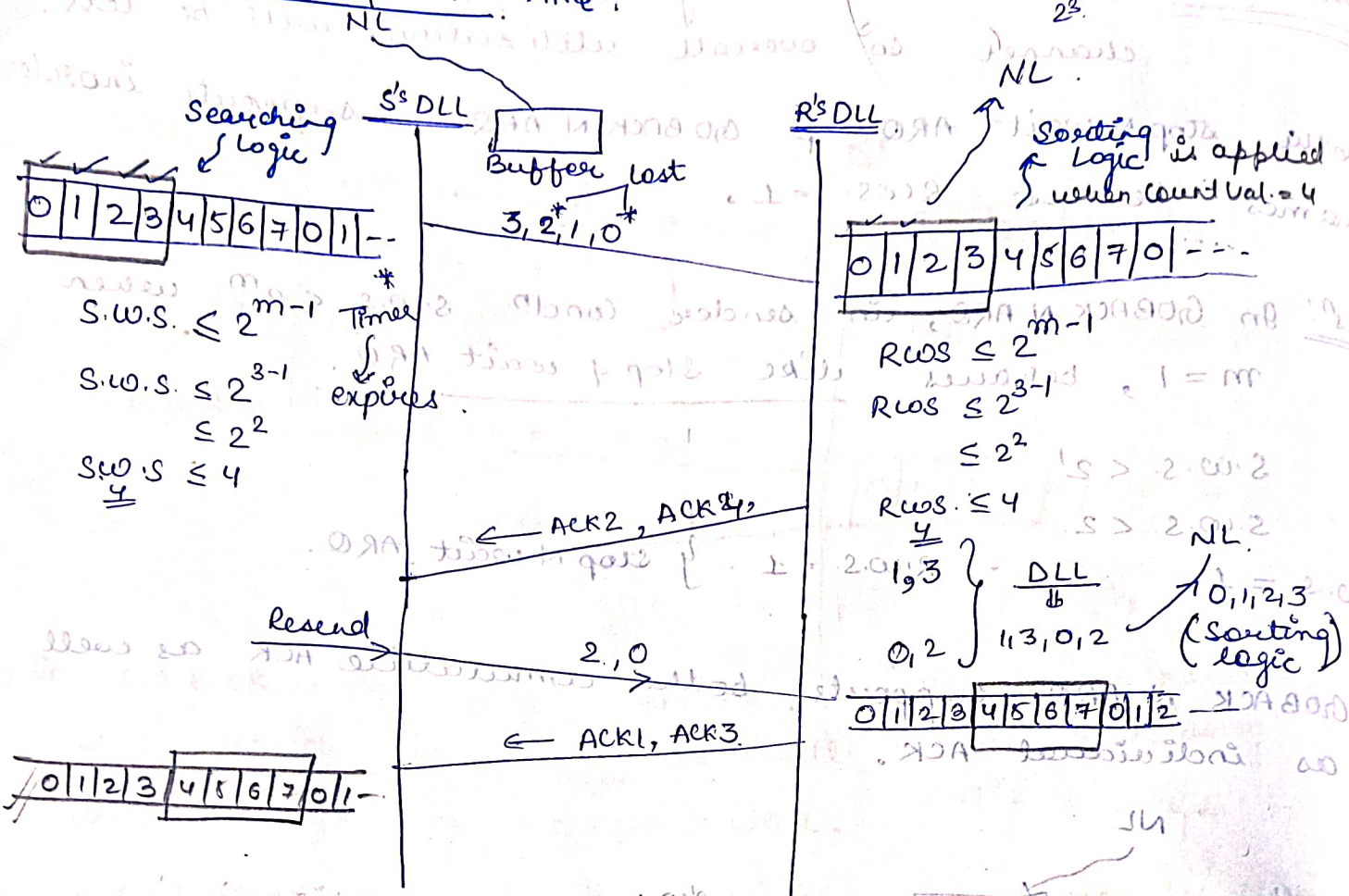
⇒



accepted (Protocol is not working)

Accepting the data, thinking that it is right but the data is wrong.

③ SELECTIVE REPEAT ARQ :-



- Selective repeat ARQ supports only individual ACK's.
- Selective repeat ARQ requires sorting logic because it accepts out of order frames but while giving to n/w layer inorder packets should be given.
- for max. utilization, GO BACK N ARQ is used.
- for noisy channels, Selective repeat ARQ is used for max. utilization.

Ques If 6 bit sequence no. is used.

	SWS	RWS
Go back N ARQ	63 ($SWS \leq 2^m$)	1
Selective Repeat ARQ.	32 ($SWS \leq 2^{m-1}$)	32

Ques If max s.w. in selective repeat ARQ is 4, # sequence bits = 3.

$S.W.S. \le 2^{m-1}$

$S.W.S. = 2^{m-1}$

$S.W.S. = \frac{2^m}{2}$

$2^m = 2\ S.W.S_{max}$

$m = \log_2(2 S.W.max)$

$m - 1 = \log_2(SWS_{max})$

$m = \log_2(SWS_{max}) + 1$

$= \log_2(4) + 1$

$\Rightarrow 2 + 1$

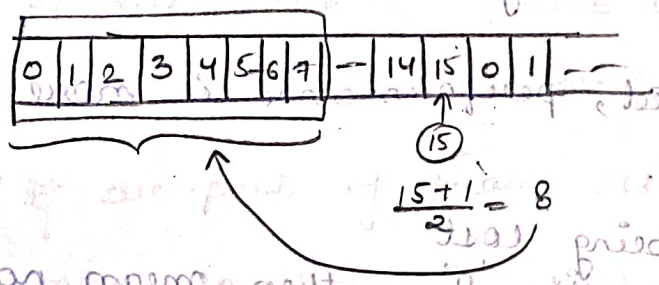
$m \Rightarrow 3$ Ans

→ If max s.w. is Q in selective Repeat ARQ then

sequence bit = $\log_2(2Q)$.

Ques If max. sequence no. = 7 in selective repeat ARQ then max. sender window = 4.

$\frac{(7+1)}{2} = 4$



odd.

2-bit → 0, 1, 2, (3)

3-bit → 0 — (7) → odd

4-bit → 0 — (15) → odd

$\frac{15+1}{2}$ even.

→ If max. sequence no. = K in selective repeat ARQ then max. sender window = $\frac{K+1}{2}$.

Ques: B.W. = 10Mbps.

RTT = 50 μsec.

frame size = 25 bits.

window size = ? 20

sequence bits in selective repeat ARQ = ? 6 bit. Ans

	S.W.S.	RWS
1 sec → 10×10^6 bit.		
50 μsec → $10 \times 10^6 \times 50 \times 10^{-6}$ bit	8	8
500 bits. × 5 bit	16	16
500/25 = 20 × 6 bit	32	32.

⊙ for maintaining same window size, selective repeat ARQ requires more sequence bits compared to GO BACK N ARQ.

⇒ Points to Remember!

Ques: which protocol will support both individual & cumulative ACK's?

Ans: GO BACK N ARQ.

Ques: which protocol ~~with~~ supports individual ACK's?

Ans: Both Stop & wait ARQ & Selective Repeat ARQ.

⊙ Buffer requirement is low in Stop & wait ARQ.

⊙ " " moderate in Selective Repeat ARQ.

⊙ " " high in GO BACK N ARQ.

⊙ When bandwidth is limited, performance is more in selective Repeat ARQ.

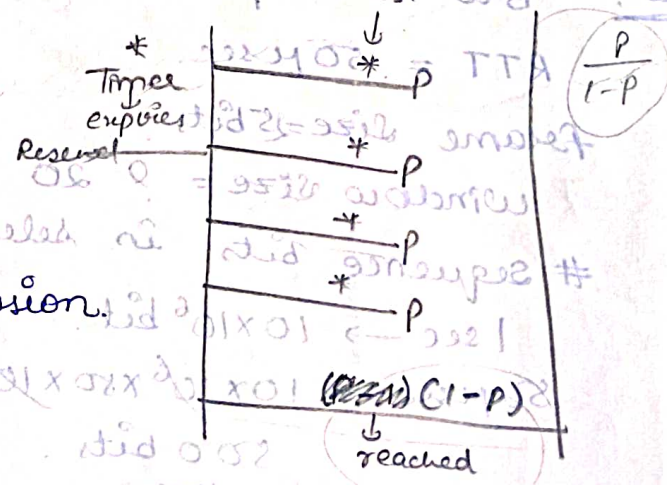
Ques: If prob. of frame being lost is 'p', then mean no. of transmissions for a frame to make it success?

Ans.

'K' transmission

P, P, P, P, ——— (1-P)

(K-1) transmission ⇓ 'K^th' transmission.



$\sum_{K=1}^{\infty} K.P(K)$ ⇒ Discrete / Discontinous.

$\int_{K=1}^{\infty} K.P(K)$ ⇒ continous.

$$= \sum_{K=1}^{\infty} K * p^{(K-1)} * (1-p)^1.$$

$$= (1-p) \sum_{K=1}^{\infty} K * p^{(K-1)}$$

$$= (1-p)\left[1 * p^{(1-1)} + 2 * p^{(2-1)} + 3 * p^{(3-1)} + \text{——}\right]$$

$$= (1-p)\left[1 + 2p + 3p^2 + \text{——}\right] \Rightarrow (1-p)^{-2}.$$

$$= (1-p)\left[\frac{1}{(1-p)^2}\right] \quad \left(\frac{1}{1-p}\right)$$

$$= \frac{1}{(1-p)}$$ Ans

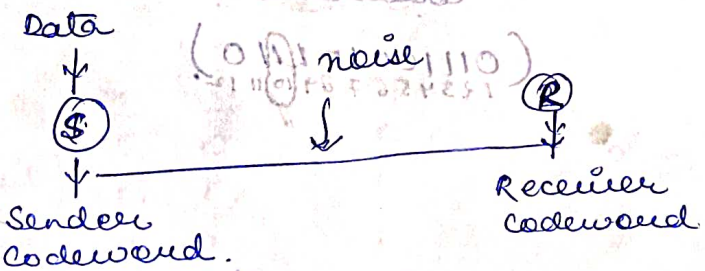
Ques: If the prob. of frame reaching safely is 'p', then mean no. of transmission of a frame $= \left(\frac{1}{p}\right)$. Ans

Ques: If the prob. of frame reaching safely is (0.1), then mean no. of transmission of a frame = 10. Ans

ERROR CONTROL POLICIES :-

(1.) Error ~~correction~~ Correction :-

(a.) Hamming Code :-



① Hamming code is a set of error-correction codes that can be used to detect and correct the errors that can occur when the data is moved or stored from S to R.

Data = 10011010.

Data + Parity bits = Codeword.

r = parity bits.

m = msg.

$2^r \geq m+r+1$

$\Rightarrow r = 3$ ✗

$2^3 \geq 8+3+1$

$8 \geq 12$. (F)

$r = 4$ ✓

$2^4 \geq 8+4+1$

$16 \geq 13$ (T)

⇒ parity bits should be placed in power of 2 position.

1	2	3	4	5	6	7	8	9	10	11	12
P_1	P_2	1	P_4	0	0	1	P_8	1	0	1	0

P_1 : $P_1, 1, 0, 1, 1, 1,$ (1, 3, 5, 7, 9, 11) follow even parity $= 0$

P_2 : $P_2, 1, 0, 1, 0, 1$ (2, 3, 6, 7, 10, 11) $= 1$

P_4 : $P_4, 0, 0, 1, 0$ (4, 5, 6, 7, 12) $= 1$

P_8 : $P_8, 1, 0, 1, 0$ (8, 9, 10, 11, 12) $= 0$

0 1 1 1 0 0 1 0 1 0 1 0

Data

↓

10011010

↓

Sender

↓

Sender codeword.

(011100101010)

noise.

Receiver

Received codeword

(011100101110)

1 2 3 4 5 6 7 8 9 10 11 12

Received codeword = 0 1 1 1 0 0 1 0 1 1 1 0

P_1 P_2 1 P_4 0 0 1 P_8 1 1 0

(0 1 1 0)

⊙ Both sender & receiver uses hamming code.

Received Parity at Received.

1	2	3	4	5	6	7	8	9	10	11	12
P_1	P_2	1	P_4	0	0	1	P_8	1	1	1	0

$P_1 = P_1\ 3\ 5\ 7\ 9\ 11 = 0$ ✓

Check $P_1 = 0$ (here)

$P_1 = 0$ (at received parity)

Both are matching no pblm.

(2) $= P_2\ P_3\ 6\ 7\ 10\ 11 = 0$

$P_4 = P_4\ P_5\ 6\ 7\ 12 = 1$ ✓

(8) $= P_8\ 9\ 10\ 11\ 12 = 1$ ✗

$2 + 8 = 10$ means error is at 10^{th} position.

⇒ Drawback!

- It will correct only single bit errors.

⊙ When noise modifies the parity bits in the codeword it will be immediately known to the Receiver by comparing with the reliable copy.

⊙ We get the reliable copy of the parity bits by sending multiple copies.

14th July is (Tuesday).

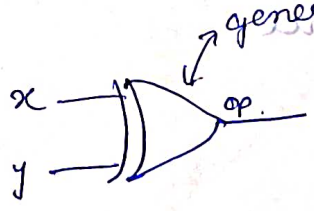
(2) Error Detection! ✓

(a) Parity scheme - (b) checksum - (c) CRC.

(a) Parity Scheme!

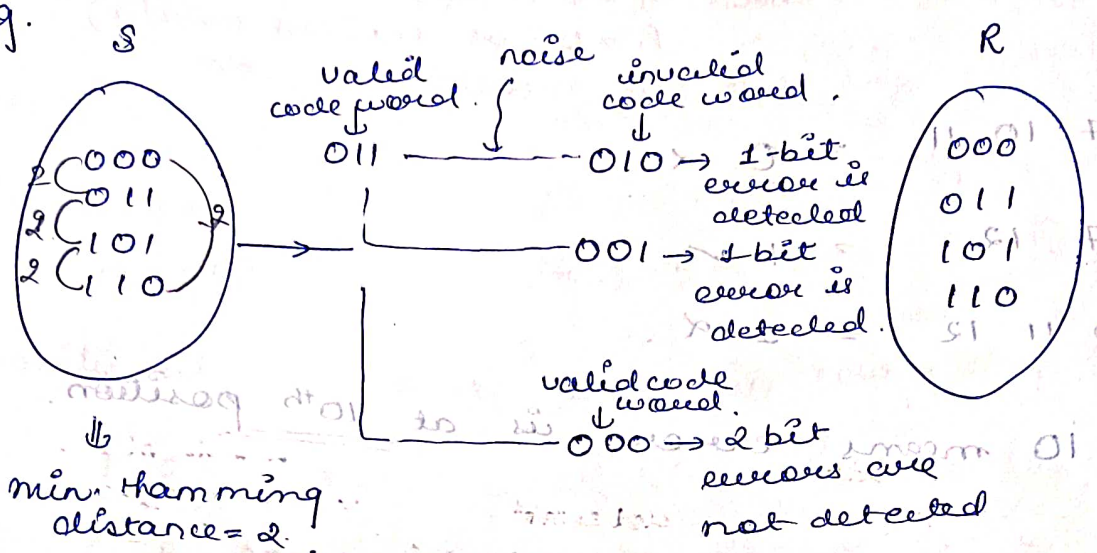
Data + Parity bits = Codeword.

	x	y	op
invalid code words	0	0	0
	0	1	1
	1	0	1
	0	1	0



codeword which is generated for the data by the ckt is known as valid codewords, & remaining all are invalid codeword.

Eg.



① A valid codeword can be converted into an invalid codeword by noise, (it can be detected)

② A valid codeword can be converted into another valid codeword by noise, (errors cannot be detected)

∴ NOTE:

Only if all possibility are satisfies then we can conclude # bits are detected.

⇒ 000 ⊗ 101 = 101.

1's = 2 = hamming distance

③ Performing XOR b/w 2 codewords will resultant another codeword.

④ The #1's in the resultant codeword is the hamming distance.

① To detect 'd' errors, the min. hamming distance 'd+1'.

② To correct 'd' error, the min. hamming distance '2d+1'.

eg.

S	R
00000000	00000000
00001111	00001111
11110000	11110000
11111111	11111111

⇓

This will work as '3' bit error.

min hamming dist. = 4.

$d+1 = 4$

$\boxed{d=3}$ Ans

4 bit

00000000 ⟶ 01010101 ⇒ detected
00001111 ⇒ not detected.

} on Note pt, all possibilities are satisfied.

(b) Checksum:

① Drawback of Parity Scheme: It cannot detect even no. of errors.

1 ✓
2 ✓
3 ✓
4 ✗
6 ✗

② Data + checksum = codeword.

Case 1:

23 53 49 73 ⟶ noise ⟶ 26 53 48 (73)

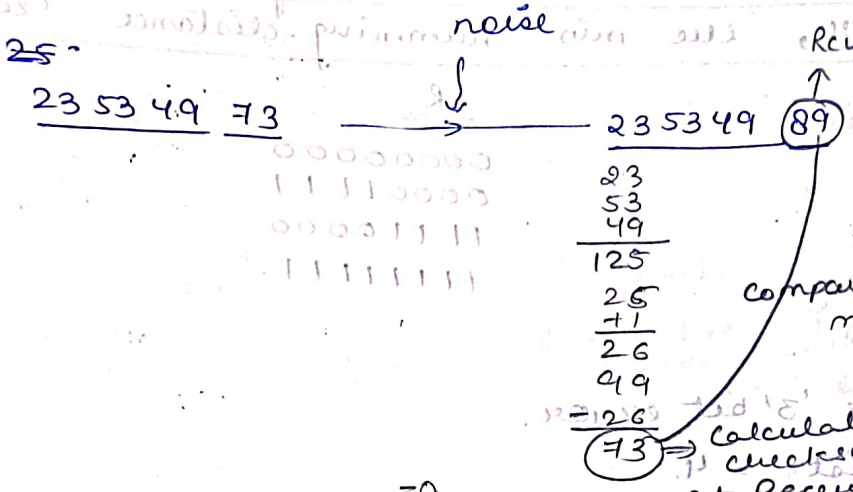
Sender	Receiver
23	26
53	53
49	48
125	127
-25	27
+1	+1
26	28
	99
	-28
	71 → Calculated checksum at Receiver.

Rcv checksum = 73

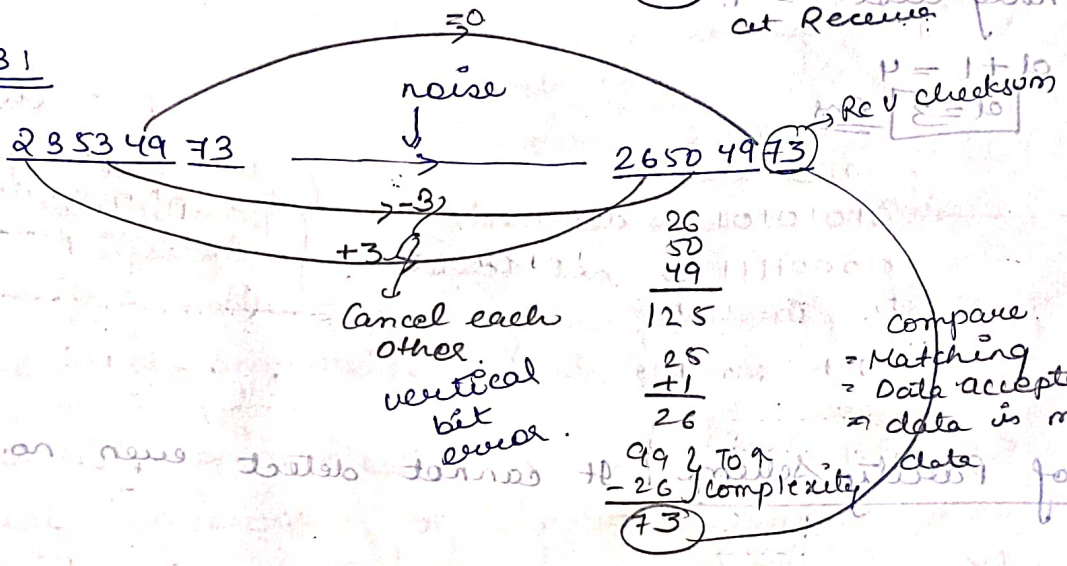
99	
-26	
73.	

Compare = Not Matching → Data is not accepted so error is error detected.

Case 2:



Case 3:

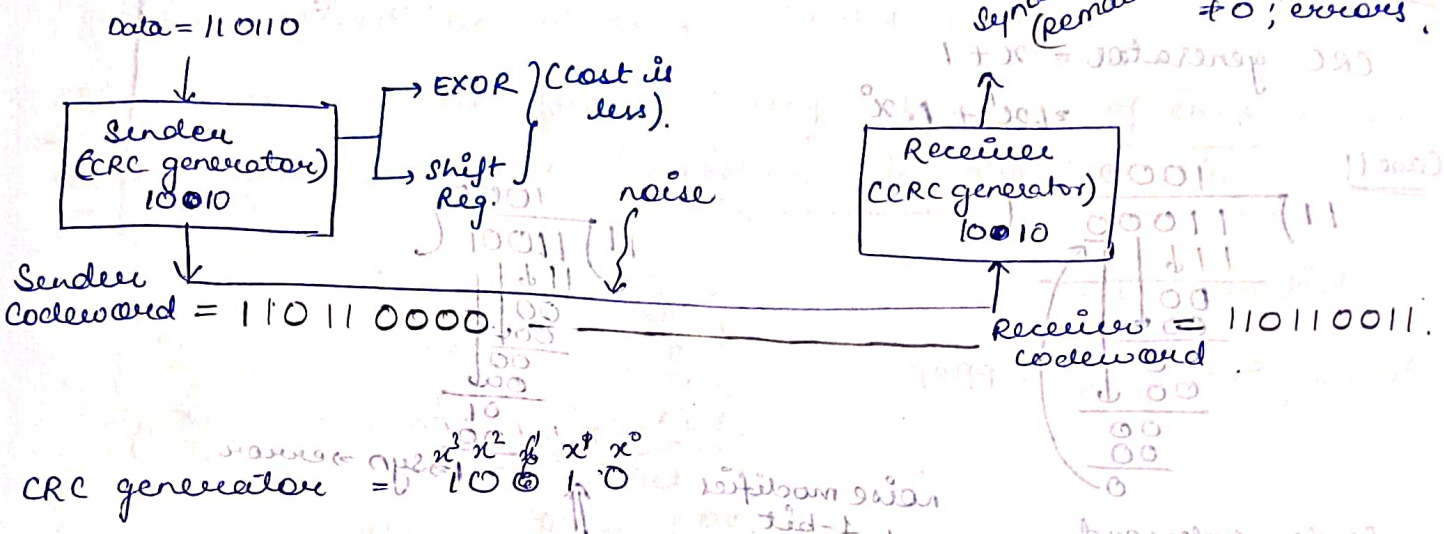


⊙ Drawback:

Vertical bit error are not detected.

⊙ If noise modifies the data in such a way that the vertically placed bits cancel each other then the calculated checksum will be equal to the received checksum then such errors cannot be detected. These errors are known as 'vertical bit errors'.

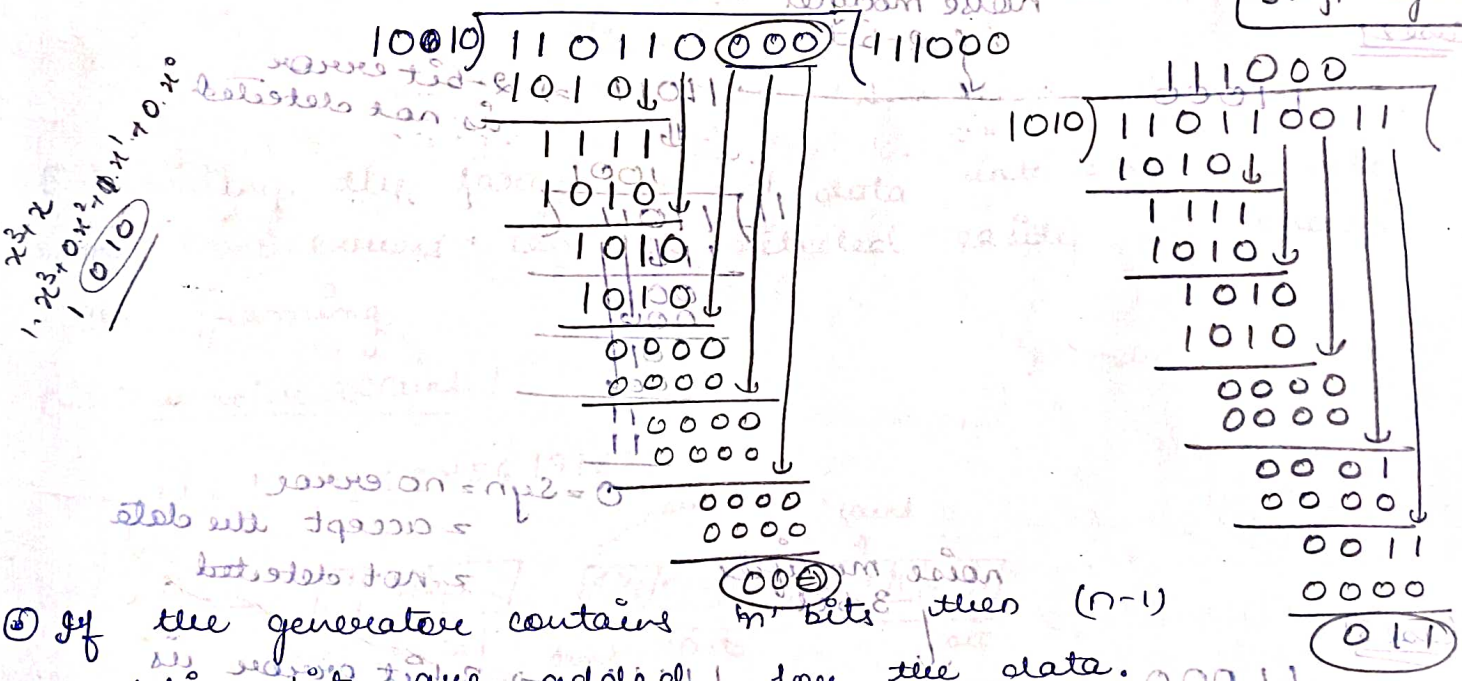
(c) CRC: { Cyclic Redundancy check }.



CRC generator = $1\ 0\ 0\ 1\ 0$ ($x^4\ x^3\ x^2\ x^1\ x^0$)

Generator polynomial = x^3+x^0

Don't calculate MSB b'coz of Shift Register



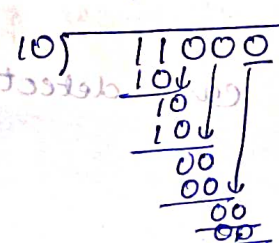
(d) If the generator contains 'n' bits then (n-1) padding bits are added for the data.

(e) The remainder at sender's side will be replaced with the padding bits.

⊙ CRC Rules: (i) CRC generator should not contain 'x'.

Data = 1100

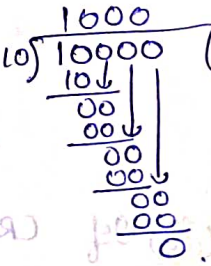
CRC generator = $x+1 = 1.x^1 + 1.x^0$



Sender codeword = 11000

noise ↓ (1+x)

Receiver codework = 10000

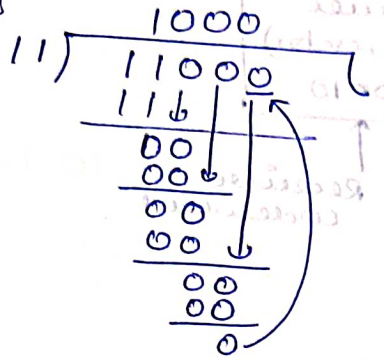


eg. Data = 1100.

CRC generator = $x+1$

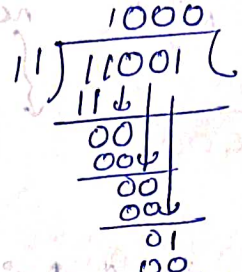
$= 1.x^1 + 1.x^0$

Case 1)



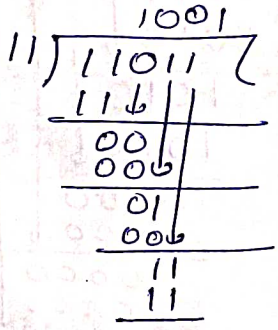
Sender codeword

11000 — noise modifies 1-bit. — 11001. ⇒ 1-bit error is detected



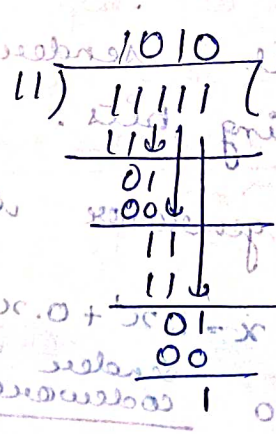
Case 2)

11000 — noise modifies 2-bit — 11011 ⇒ 2-bit error is not detected



Case 3)

11000 — noise modifies 3-bit. — 11111 ⇒ 3-bit error is detected.

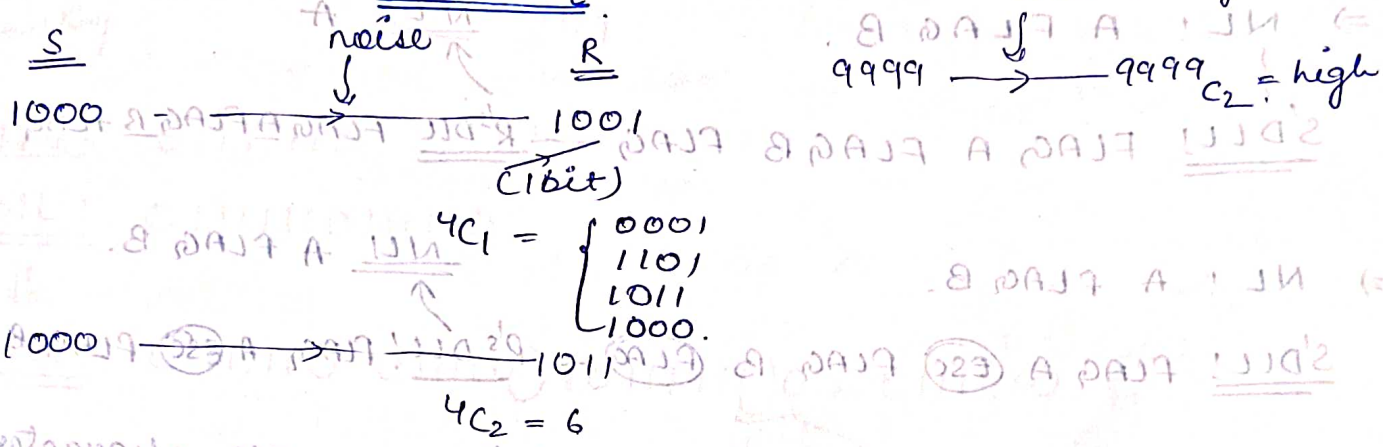


(iii) If CRC contain $(x+1)$ as a generator it can detect odd no. of errors.

⊙ CRC-32 detects all types of errors. (parity bit error, even no. of error, odd no. of error etc.).

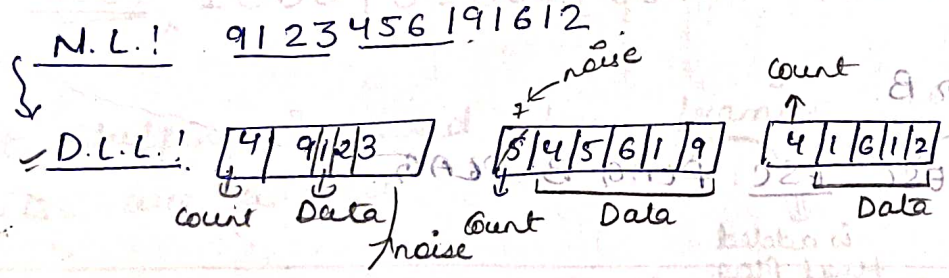
⊙ CRC-32 is a std. for detecting all types of errors, so this used for error detection in the LAN n/w.

FRAMING



⊙ Dividing the large amt. of data into smaller parts so that errors can be detected easily is known as framing.

(i) Character count:



⊙ In character count technique, a count value indicates the size of the frame.

⊙ If noise modifies the data, error detection scheme can detect the error easily.

⊙ If noise modifies the count value both sender & receiver are out of synchronization.

(iii) Character stuffing:

⇒ NL! AZ.

S'DLL! FLAG AZ FLAG ——— R'sDLL. FLAG AZ FLAG

DLL! AZ.

⇒ NL! A FLAG B.

S'DLL! FLAG A FLAG B FLAG ——— R's DLL FLAG A FLAG B FLAG

N.L! A

⇒ NL! A FLAG B.

S'DLL! FLAG A ESC FLAG B FLAG ——— R's DLL! FLAG A ESC FLAG B FLAG

NLI A FLAG B.

① When a flag occurs in the data an ESC character is stuffed to indicate that the FLAG is a data.

② If flag is prepended by ESC then a flag is a data.

③ If flag alone come then it is the end of the data.

⇒ NL! A ESC FLAG B

⇒ S'DLL! FLAG A ESC ESC ESC FLAG B FLAG.

ESC is added that flag is a data

(iii) Bit stuffing:

① Drawback of char stuffing: If more flags occures in the data then more no. of bits should be added. So overhead size increases.

$ expr 4 * 3 [* => all] $ expr 4 / 2 [/ = root]

$ expr 4 * 3 → ES

= 12.

$ expr 4 \/ 2 → 2

eg. NL! 01111110

flag. 01111110

DLL! 011111 0 10110. 01111110.

after bit stuffing. ^ flag.

FLAG! 01111 10. flag has 5 1's so in data, put 0 after 4 1's.

eg. FLAG! 01111110

NL! 01111101111110.

⇓

DLL! 01111110 011111 0 10111110. 01111110.

⇓

If you don't stuff 0 here, DLL removes this 0 but it's a part of data.

eg. N.L.! 1000010000011.

FLAG! 100001.

100001

DLL! 1000 1 0 1000 1 0011. 100001.

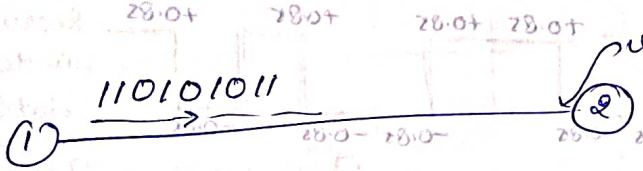
^

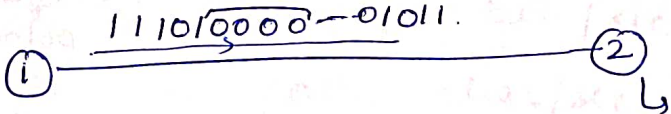
① Bit stuffing is used for framing because less no. of bits are added.

Synchronization problem for data!

1 ⇒ +5V

0 ⇒ 0V





↳ ambiguity (synchronizatn pblm)

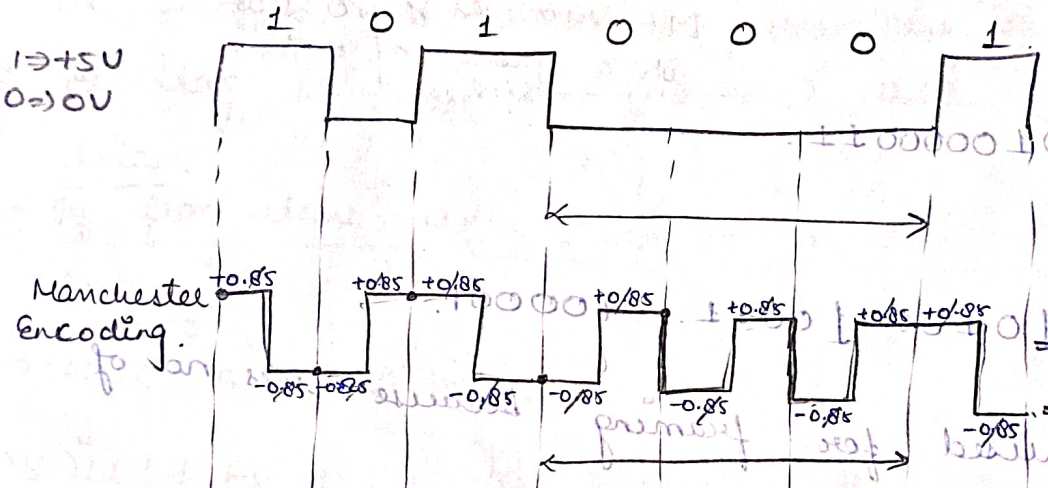
⊙ high bandwidth signals :- (more no. 1's)

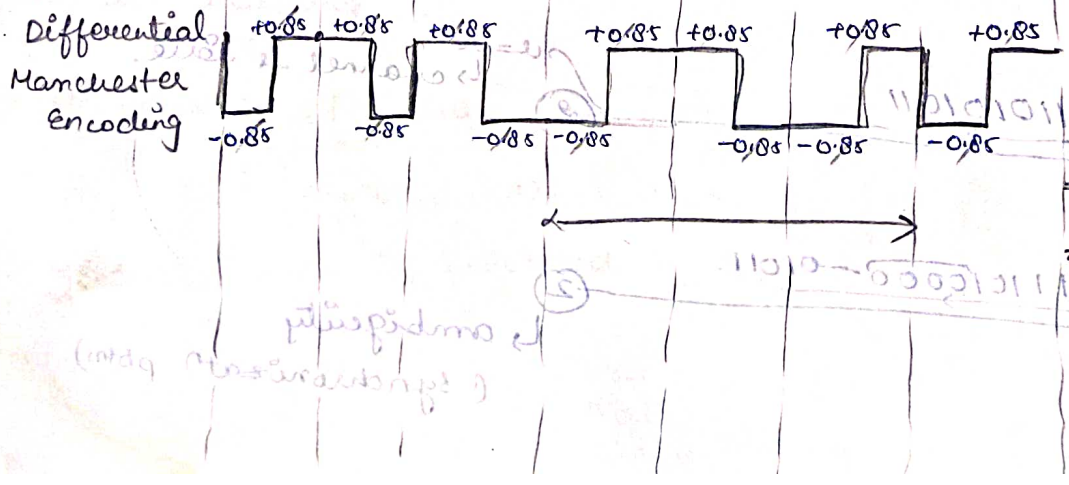
⊙ To solve these pblms, encoding is used. which is takencare by Physical layer.

⊙ when data contains continous 0's., receiver cannot understand whether the channel is coming or approach.

⊙ when the data contains more no of 1's, then there is a possibility of high dc current.

ENCODING





⇒ Manchester Encoding : Used by IEEE 802.3. (Bus topology).

1 → +0.85V, −0.85V (high → low)

0 → +0.85V, −0.85V (low → high)

In manchester encoding the bitrate is half of the baud rate.

⇒ Differential Manchester Encoding : Used by IEEE 802.5 (ring topology)

↳ waveform will be alter.

1 → transition (change)

0 → No transition (no change)

⇒ Drawback : It occupies twice the bandwidth of normal value.

⇒ Advantage :-

⊙ It provides synchronizath & eliminates the high dc current

Serial Data transfer

(i) Synchronous Serial data transfer.

(ii) Asynchronous Serial data transfer.

(i) If synchronous serial transfer if 3 eight bit sync characters are included in 30 (eight) bit info. character & B.W. = 1200 bits/sec, what is the data rate of a receiver?

24 sync bits ⟷ 240 info bit

$= \frac{24 * 1200}{240}$ ⟷ 1200 bit.

= 120 sync bits.

data rate of a receiver = (1200 − 120) bits/sec

$= \frac{1080}{8}$ char/sec

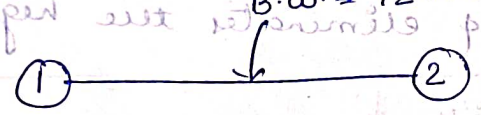
= 135 char/sec.

1 char = 8 bit

⊙ In synchronous serial transmission, sync bits are added for grp of characters.

⊙ These bits are not taken by the receiver, these are only to alert the receiver that the data is approaching.

(ii.) In asynchronous serial transfer, if 1 start bit, 2 parity bits and 1 stop bit are given for a character and the B.W. of the channel is 1200 bps. what is the data rate of receiver?



data rate of a receiver = 1200 bits/sec

$$= \frac{1200 \text{ bits/sec}}{1 + 2 + \text{Byte} + 1} \text{ char/sec}$$

$$= \frac{1200}{(1+2+8+1)} \text{ char/sec.}$$

$$\Rightarrow 100 \text{ char/sec}$$

⊙ In asynchronous serial transfer, the extra bits are added for every character.

⊙ The extra bits are treated as part of data by the receiver.

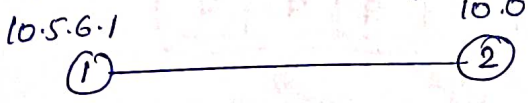
⊙ Normally, the MAC address is visible in LAN but this can be accessed outside the LAN by using mapping technique i.e. MAC addr. mapped to private IP, private IP mapped to public IP.

⊙ Longest prefix Matching!

whenever a packets comes to a router & router has multiple paths then the path which is having the longest path i.e. more no. of 1's should be preferred.

⊙ Ping! N/w comm.

Packet Internet groupher.

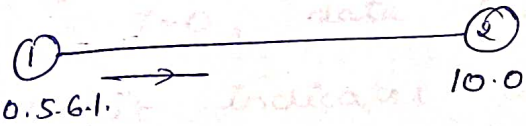


C:|> Ping -t 10.0.0.7.

TTL=2msec,

⇒ loop back address!

127.x.y.z.



C:\> Ping -t 127.0.0.1.

TTL = 2msec, RTT=.1msec

	SIP	DIP.
P	10.5.6.1	127.0.0.1

⊙ Loop back address will never enter into the n/w.

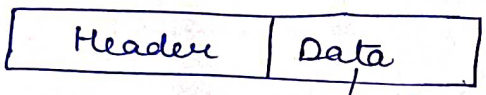
⊙ Loop back addr. will always be used as destination address.

⊙ It is used for inter-process comm. but both process should be in same system.

D.L.L

- **LLC layer** ⇓ Logical link control layer. ⇓ flow ctl, error ctl, conn^n establishment.
- **MAC layer** ⇓ Medium Access control layer. ⇓ uses to reduce the no. of collisions. ⇓ Sys. interacted with the NIC card.

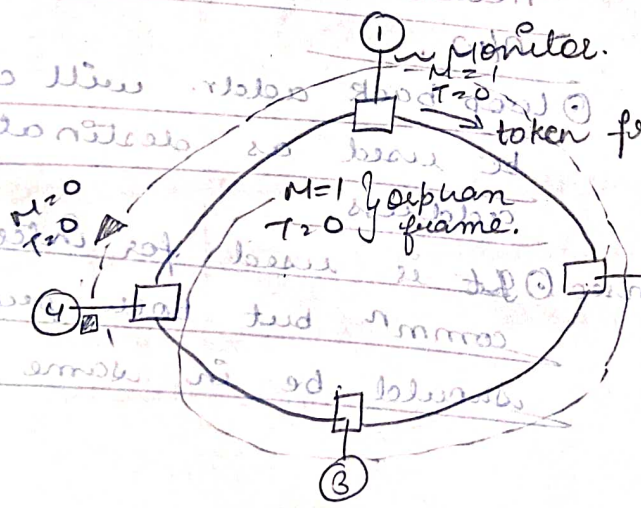
⊙ LLC layer:-



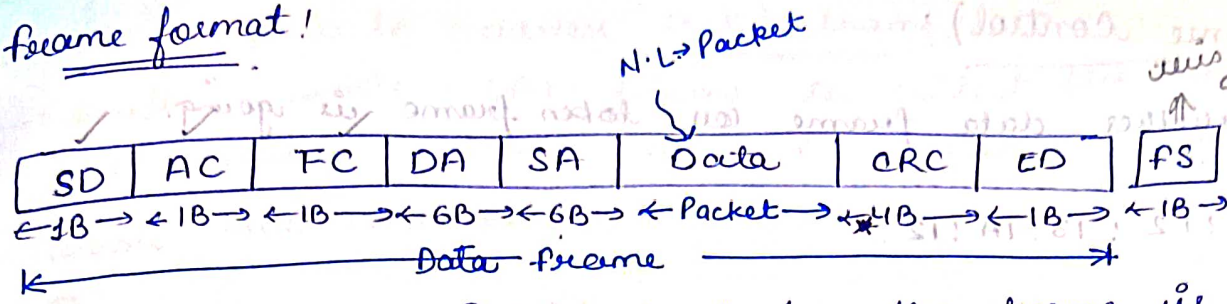
- Payload
- PDU (Protocol Data Unit)

15th July's IS {Wednesday}.

IEEE 802.5 (TOKEN Ring).



① frame format!



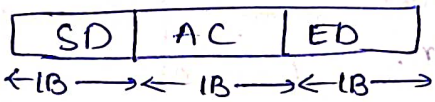
① SD (Starting Delimiter) indicates the frame is starting.

① ED (Ending Delimiter) indicates closing of the frame.

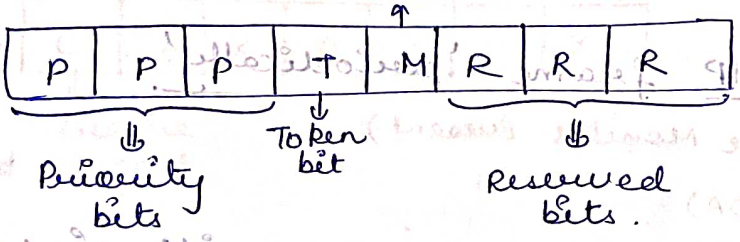
① By default, token frame = 3B.

Protocols ⇓ set of rules

① Token frame format!



① AC = Access control.



① In the ring topology, systems can be assigned priorities with the help of priority bits.

① If T=1, token frame.
T=0, data frame.

① 'T' bit indicates whether the entity is data frame (or) token frame.

① Any system that transmitted the data will have T=0, M=0.

① Once it passes by monitor 'M' value becomes 1.

① During this time, if destn system is crash then again the same frame will come to the monitor with M=1, then this frame is treated as orphan frame.

⑥ FC (frame control):

Decides whether data frame or token frame is going.

→ 04 : 13 : 12 : 13 : 1A : 12.

→ 00000100.

1st bit = 0 = Unicast MAC addr.

→ 9A : 13 : 12 : 1f : 1A : 12.

10011010

→ 1st bit = 1 = Multicast MAC addr.

→ FF : FF : FF : FF : FF : ff = Broadcast MAC addr.

⑦ Monitor sends ① AMP frame 'periodically'.

(Active Monitor present)

(SA, DA)

⑧ Once monitor crashes, then a system with highest priority will become new monitor.

⑨ A system who wants to become a monitor will send a ② claim token frame.

⑩ claim token frame after rotation, it will stop at the highest priority station then that system will become monitor by sending the AMP frame.

⑪ When the link is broken the data will become ③ corrupted frame or stray frame.

⑫ Downstream station will send ④ beacon frame to inform to all station abt the breakage of the link.

⑬ Monitor sends ⑤ purge frame to clean the ring and to remove the stray frame.

⑥ DAT (Duplicate address test) frame:

Monitor sends DAT frame to collect the MAC addresses & to ensure that no 2 systems have the same MAC address.

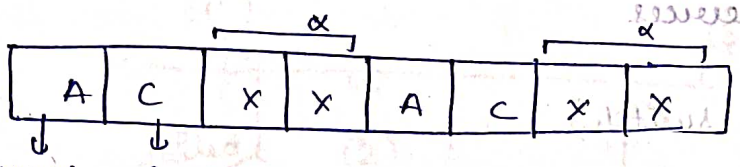
⑦ Stand by Monitor frame

Monitor sends stand by Monitor frame to elect a new monitor w/o any election process.

⑧ CRC is providing error control for the entire frame.

(CRC is providing error ctrl for DLL not for N.L.)

⑨ FS (frame status):



Address recognised bit.

Frame copied bit.

if noise modifies the ACK,

A=1, C=1; data reached safely.

A=1, C=0; destn system is busy.

A=0, C=0; destn system is crashed. (Treated as orphan frame which is decided by the Monitor)

A=0, C=1; {Sometimes not possible, w/o recognizing the addr, how can be the frame bit is copied}

⑩ CRC provides the error ctrl for FS as well.

⑪ Multiple copies of ACK are transmitted for cross-checking by the source.

⑫ If noise modifies the ACK, it can be known with the help of CRC.

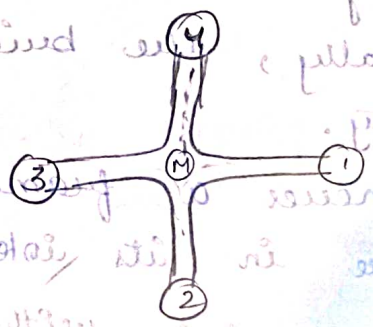
⇒ IBM (specification):

a) B.w of ring (4 Mbps (or) 16 Mbps)

b) Physical structure = Star topology.

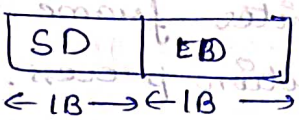
c) Logical structure = Ring topology.

d) Differential Manchester encoding.



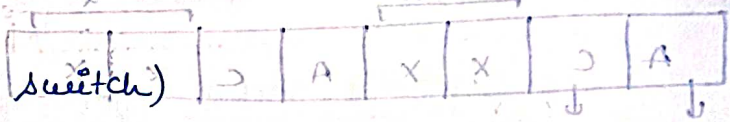
⑥ In single rotation, Monitor will touch the frame only once, so that Monitor doesn't treat it as a orphan frame.

⑦ Monitor sends Abort frame to keep the channel ideal for sometime.

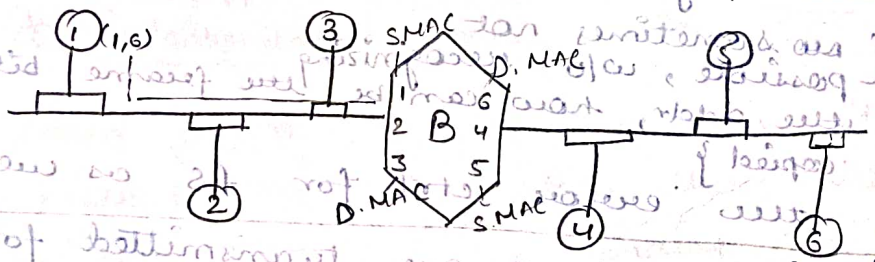


NETWORKING DEVICES

① Hub. } Passive devices.
② Repeater. }
③ Bridge ⇒ (2-layer switch)
④ Router. } Active devices.
⑤ Gateway. → (3-layer switch).
→ (All-layer switch)



③ Bridge:



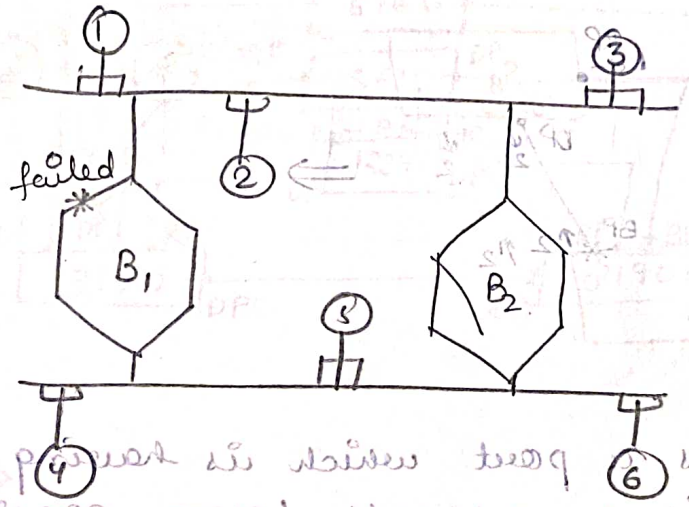
① Bridge is a LAN device and its operation is based on MAC address. (MAC addr. is only visible only in LAN n/w)

② Bridge is used b/w for connecting similar LAN n/w.

③ Initially, the bridge table of the bridge will be empty.

④ Whenever a frame reaches to the bridge, it will store in its internal buffer, a dummy frame is created with the dest^n addr. of the frame.

and it broadcast on the other LAN.

- If there is a reply then bridge will update the table with the dest^n add, this is known as learning.
- Now the data is stored in a buffer of bridge is transmitted to the other side of the LAN, this is known as forwarding.
- When the data is transmitted to the same side of the LAN, it is known as blocking.
- When bridge knows the complete info. of the n/w it is treated as convergence & stable.
- 

- 2 or more bridges are connected b/w similar LAN's to support fault tolerance.
- When more than 1 bridge is connected b/w the LAN's there is a possibility of forming loops b/w the bridges, so the graph should be converted into tree by using spanning tree protocol.
- Apply this protocol b/w the bridges.

⇒ Spanning Tree Protocol:

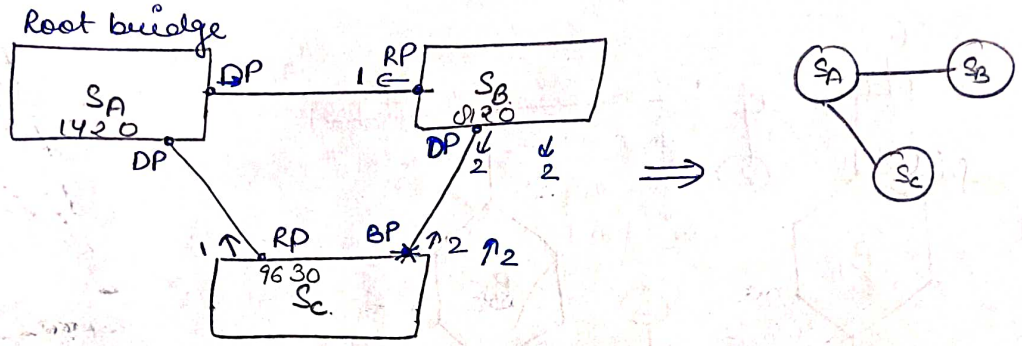
(1) Root bridge: The bridge which is having the lowest MAC addr. will become root bridge.

iii.) Root port: It is a port which is having the least cost path from non-root bridge to root bridge.

① This port is used for sending the data from non-root bridge to root bridge on behalf of computers. (Every root has only one Root B Port)

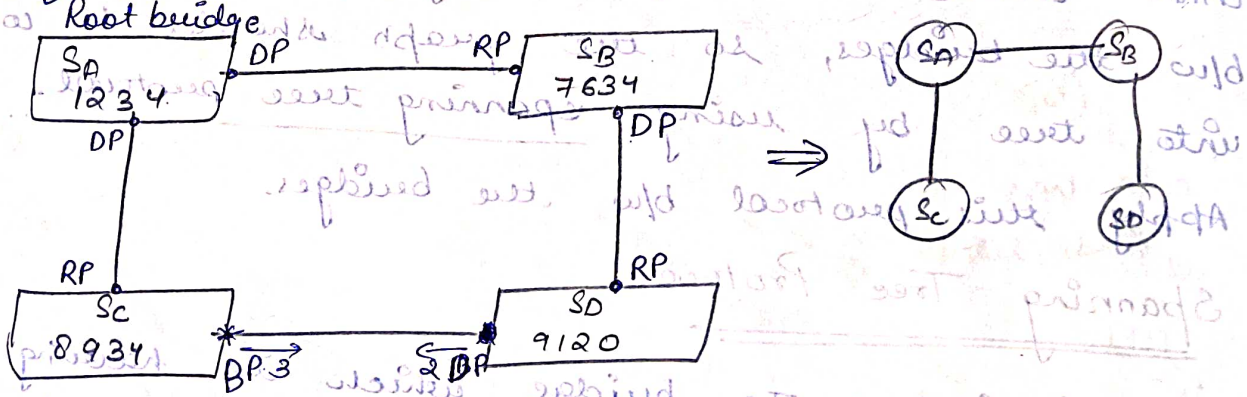
iii.) Designated port: is a port which is having the least cost path from root bridge to non-root bridge. (opposite of root port).

eg.

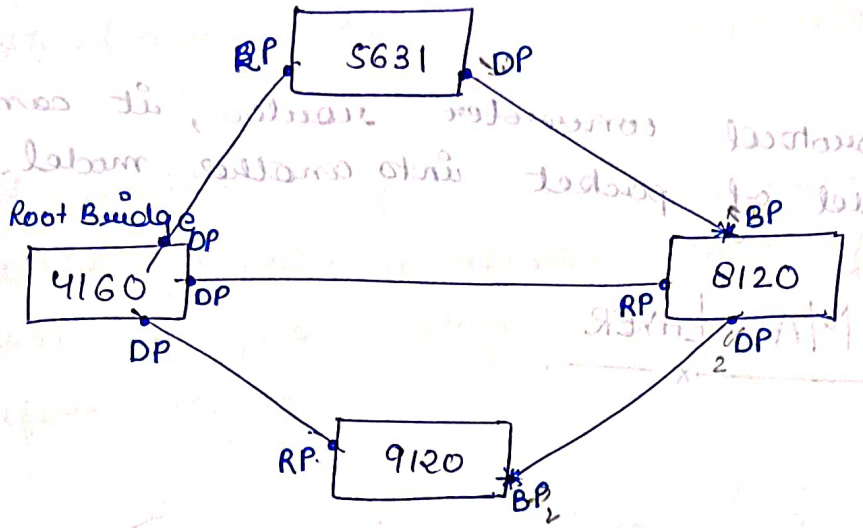


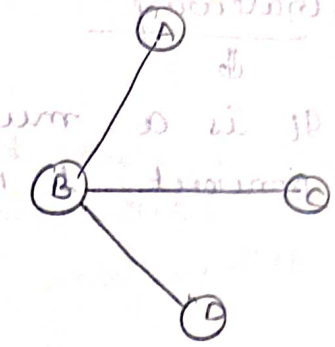
iv.) Blocking port: is a port which is having highest cost path from non-root bridge to root-bridge. (opposite of BP = DP)

Ques:



Ques^n!

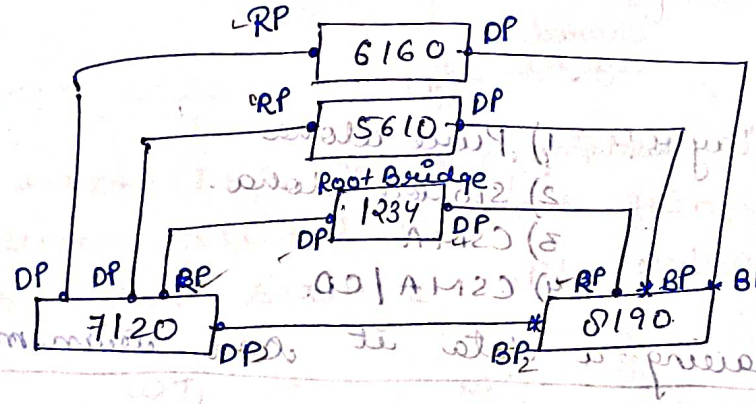


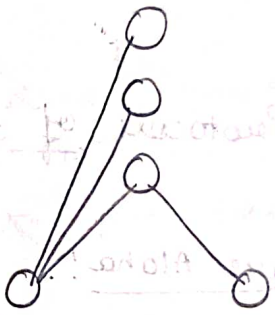


BP = 2.

Verify it we ~~cant~~ connect C & D it forms loops, if we connect A,C, it forms loops.

Ques^n!





BP = 3

④ ⟹ Router !

⟺

⑤ Router is a WAN device & its opⁿ is based on IP address.

⑥ Router is used for connecting different classes of n/w.

⑦ By default, router is a broadcast domain separator.

⑧ Router is used for connecting different n/w's [dissimilar n/w's].

⑨ Router is not a multiprotocol converter. because it cannot convert 1 model of packet into another model.

By default,

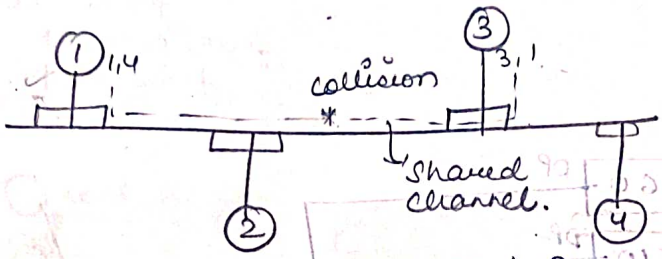
⑩ Router is a collision domain separator.

⑤ Gateway!

⇓

It is a multiprotocol converter router, it can convert 1 model of packet into another model.

MAC LAYER



⇒ Protocols of MAC Layer :- 1) Pure aloha.
2) Slotted aloha.
3) CSMA.
4) CSMA/CD.

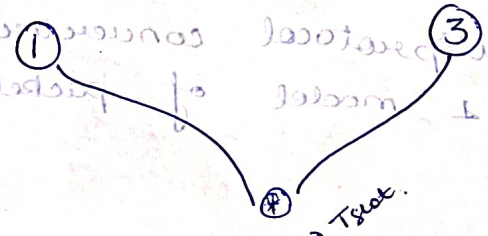
1) Pure Aloha!

⊙ Any system is having a data it can steansmitt immediately.

⊙ The time at which collision occurs is known as vulnerable time.

⊙ When the data are collided stations has to wait random amt of time before retransmitting the data, this time is known as back-off time & is given by exponential back off algo.

EXPONENTIAL BACK OFF ALGO!-



$WT_1 = (0 \text{ to } 2^K - 1) * P.T.$ $WT_3 = (0 \text{ to } 2^K - 1) * P.T$

K = 1.

$WT_1 = (0 \text{ to } 1) * P.T$; $WT_3 = (0 \text{ to } 4) * PT$

K = 2.

Ques! If stations 1 & 3 have transmitted their data, collided & waits a random amt of time then what is prob. that station 1 will retransmitt before station 3?

Soln!

WT_1	WT_3
0	0
P.T	P.T

(0 → Retransmitt; 0 PT; PT 0; PT PT)

reward is $\frac{1}{4}$ = 1/4 Ans.

Ques!@ If stations 1 & 3 have transmitted their data for the 2nd time, collided. & 1 waits then (2) what is the prob. that Stat^n 1 will retransmitt before Stat^n 3.

WT_1	WT_3
0	0
1 PT	1 PT
2 PT	2 PT
3 PT	3 PT

$= \frac{3+2+1}{16} = \frac{6}{16} = \frac{3}{8}$ Ans

(b) In the above pblm, what is the prob that Stat^n 1 & 3 have retransmitt exactly at the same times.

$= \frac{4}{16} = \frac{1}{4}$ Ans

0 to 2^{i-1}
0 to 2^0
[0 to 1]
0 to 2^i
0 to 2^1
0 to 2^2
0 to 2^3

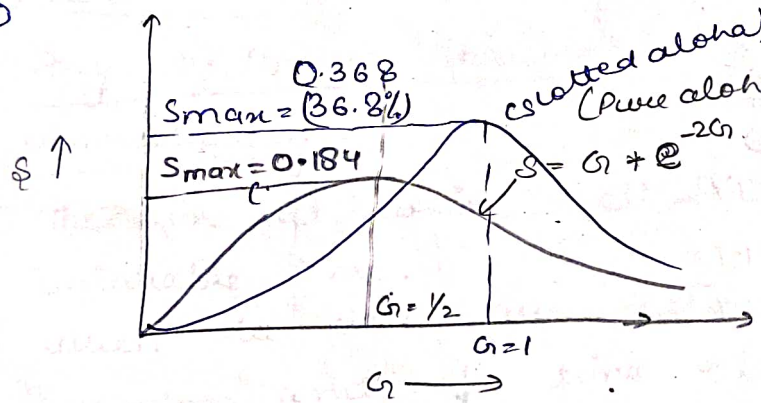
⊙

(LAN) Stations	transmitting the data		Station's data safely reached	collisions
100	50	$= \frac{50}{100}$ {underload}	30	20
100	100	$= \frac{100}{100}$ {critically loads}	50	50.
100	50		40	10
100	200	$= \frac{200}{100}$ {overload-ed}		

① The data i.e. transmitted in different instance of time is known as channel load. (G)

② The rate at which user transmits the data & the data should safely reach dest^n is known as throughput (S).

③



(slotted aloha) $S = G * e^{-G}$

(Pure aloha) $S = G * e^{-2G}$

G = avg no. of frames transmitted through the channel during a period of 1 frame transmission.

$S = G * e^{-2G}$ (throughput)

$\frac{dS}{dG} = 0$, Smax

$Smax \Rightarrow G * (-2) . e^{-2G} + e^{-2G}$

$\Rightarrow e^{-2G} (1 - 2G) = 0$

$\Rightarrow 1 - 2G = 0$

$\Rightarrow 1 = 2G$

$\Rightarrow G = \frac{1}{2}$ } max. throughput.

$$S = \frac{1}{2} * e^{-2 \times \frac{1}{2}}$$

$$S = \frac{1}{2} * e^{-1}$$

$$\boxed{S = \frac{1}{2e}} \Rightarrow \boxed{S_{max} = 0.184} \Rightarrow \boxed{S_{max} = (18.4)\%}$$

⊙ In pure aloha, out of 100 frames that are transmitted only 18.4 frames maximum will reach the destn, remaining will suffer from collisions.

(ii) B.W. = 100 Mbps.

max. throughput of pure aloha =

18.4% of B.W.

⇓

⇒ 18.4% of 100 Mbps.

⇒ $\frac{18.4}{100} \times 100$ Mbps

⇒ 18.4 Mbps throughput.

throughput for $G = 1$:

$S = G * e^{-2G}$

$= 1 * e^{-2*1}$

$= e^{-2} = 0.135 = 13.5\%$

13.5% of B.W.

$= \frac{13.5}{100} \times 100$ Mbps

$=$ 13.5 Mbps. throughput.

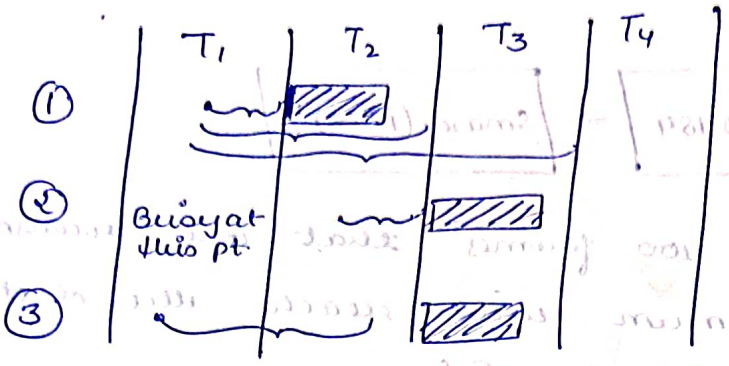
∴ $18.4 > 13.5$

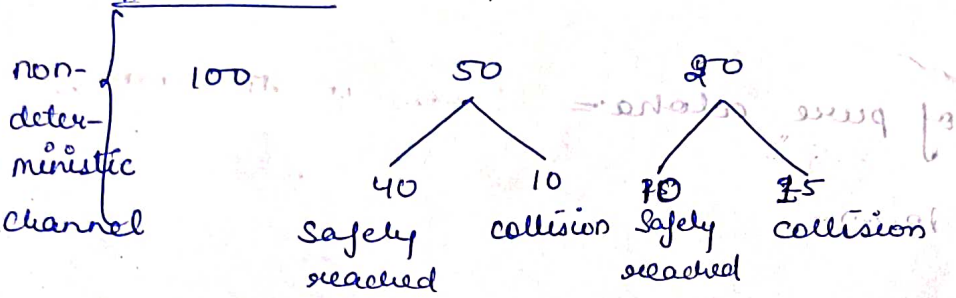
⇓

less because { any other value we take other that $G = 1/2$, it give less throughput, }.

2.) Slotted Aloha!

⊙ System transmitt the data in time slots.





⇒ non-deterministic (not depend on previous history)

$S = G * e^{-G}$ (Throughput).

$\frac{dS}{dG} = 0$

$G * (-1)e^{-G} + e^{-G} = 0$

$e^{-G}(1 - G) = 0$

$\boxed{G = 1}$ ⇒ max. throughput i.e. S_{max}.

$S = G * e^{-G}$

$= 1 * e^{-1}$

$S = \frac{1}{e} = 0.368$

$= 36.8\%$

⊙ In slotted aloha, out of 100 frames that are transmitted.

⊙ The throughput of slotted aloha is double that of pure aloha.

3.) CSMA :-

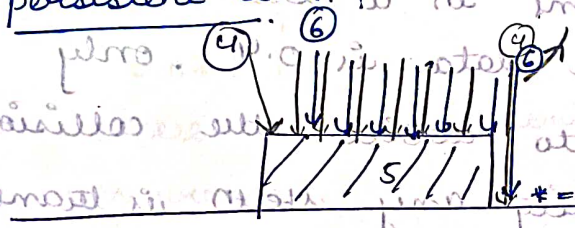
↳ Carrier Sense Multiple Access.

⊙ When energy = low, the channel = ideale.

⊙ When energy = moderate, the channel = busy.

⊙ When energy = high, collisions are there if there is a collision in the n/w.

a) 1-persistent CSMA (Go ni transmits).

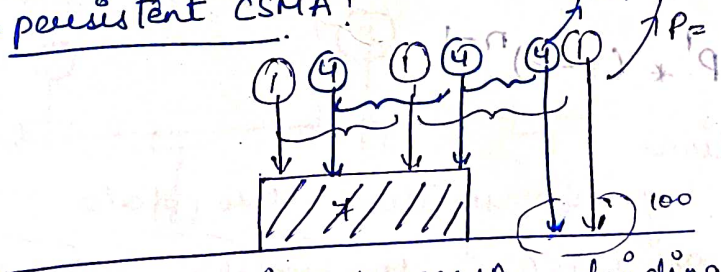


⊙ Stations continously sense the channel when the channel is busy.

⊙ Once the channel is ideal it will transmit immediately.

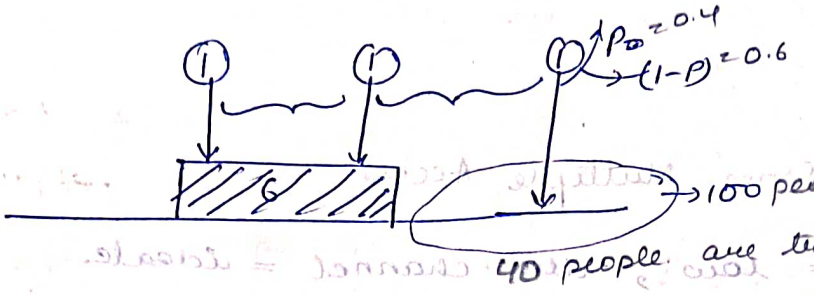
⊙ If 2 (or) more systems find the channel is idle at the same time, then there is a possibility of collision.

b) Non-persistent CSMA!



⊙ In non-persistent CSMA, finding the channel idleness at the same time is less for different stations. So the possibility of collisions will be less.

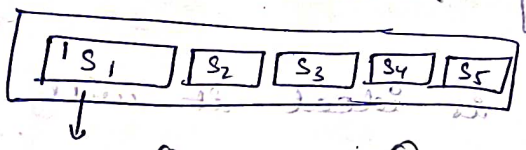
c) P-persistent CSMA:



⊙ In p-persistent CSMA, once the channel is idle it may transmit with prob. 'p' or it may not transmit with prob '(1-p)'.

Ques?: There are 5 stations in a slot, the prob. of transmitting the data is 0.4. only 1 station should transmit to avoid the collision then what is the probability any station is transmit?

Ans:



$= (1) * 0.4^{(1)} * (1-0.4)^{5-(1)}$ → 1st station

$= (1) * 0.4^{(1)} * (0.6)^{4}$ + 2nd station

$1 * 0.4^{1} + (0.6)^{4}$ +

$= 5 * (0.4)^{1} * (1-0.4)^{5-1}$

$= {}^{n}C_{1} * p^{1} * (1-p)^{n-1}$

n = # stations

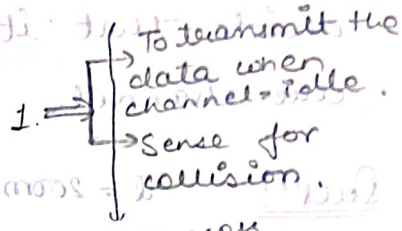
p = prob. of transmitting the data.

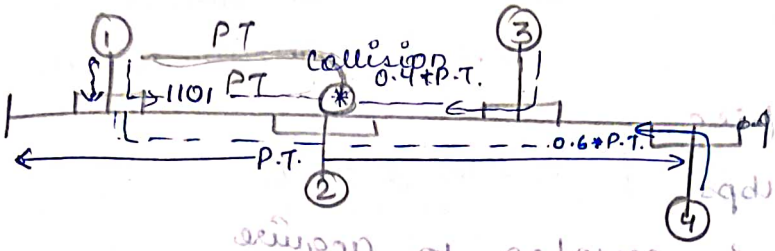
1 = Only 1 station is transmitting the data

(1-p) = prob. of not transmitting the data.

CSMA/CD

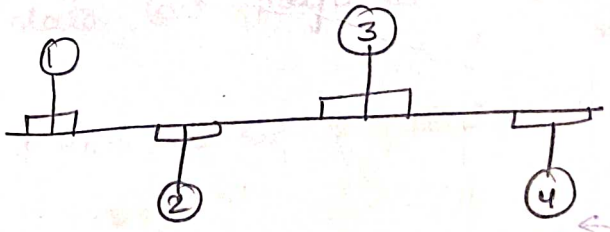
↳ Carrier Sense Multiple Access / collision detection.





Collision Occurence	collision detection
0.4 * P.T.	0.8 * P.T.
0.6 * P.T.	1.2 * P.T.

- The place where the collision happen is known as collision occurence.
- When the collision energy came through the sender interface then collision is detected.
- Until the collision detection the station has transmitted the data, now it will stop transmitting the data.
- Range of collision occurence :- (0 to P.T.)
  Range of collision detection :- (0 to 2P.T.)



- The max. time to detect a collision is detected stations will wait a random amt of time using exponential back-off algo. '2*P.T.' Once

④ If collision is not detected at less than 2PT. (or) at 2P.T. then at 2.P.T. the station can decide that it has captured the channel (or) acquired the channel.

Quesn! $l = 200m$.

$v = 2 * 10^8 m/sec$

B.W. = 100Mbps.

Min. frame size in CSMA/CD to acquire the cable.

Soln. $TT = 2PT$

$\frac{DS}{BW} = \frac{2 \times l}{v}$

$\frac{DS}{100 \times 10^6} = \frac{2 \times 200}{2 \times 10^8}$

$DS = 200$ bits. Ans.

Quesn: 10 Base 5 cable is used.

$v = 2 \times 10^8$ m/s.

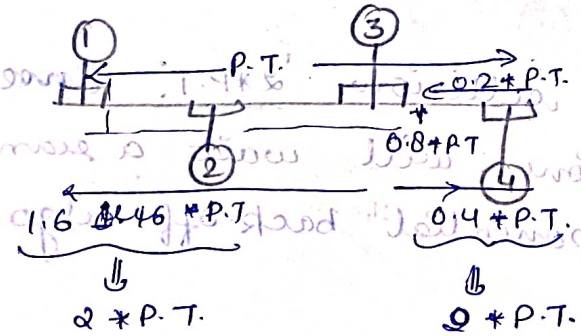
Min. frame size in CSMA/CD = ?

Soln. $TT = 2PT$.

$\frac{x}{10 \times 10^6} = \frac{2 \times 500}{2 \times 10^8 \cdot 10}$

$x = 50$ bits.

⑤



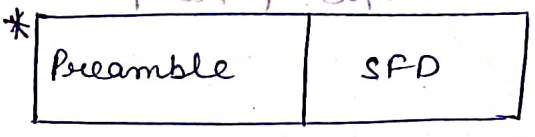
⊙ If collision is detected at less than 2P.T. then upto 2P.T. jamming signal will be transmitted.

⊙ The purpose of jamming signal is to inform the other stations not to send the data.

⊙ If the collision is detected exactly 2P.T., jamming signal value will be zero.

IEEE 802.3 {Bus topology}

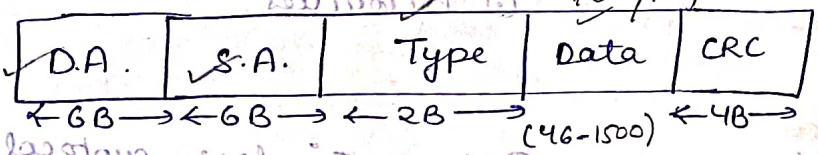
⇓ Supports CSMA/CD.



This part is added physical layer.

→ Used Bridge ⇓ MAC-addr

→ Not using bridge ⇓ MAC addr & Private IP addr.



16th July'15 Thursday

⊙ Preamble & SFD is to provide synchronization b/w sender & receiver.

⊙ Min. frame size to support CSMA/CD = 64B. TT = 2PT (10base5)

⊙ min. data (or) payload = 6+6+2+x+4 = 64B.
⇒ x = 46B (expects from N/w layer)

64B & 46B ⇒ for acquiring the channel.

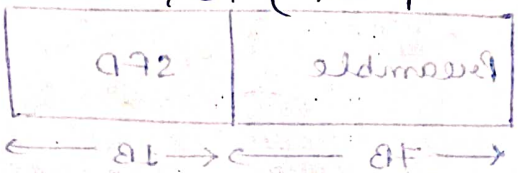
Restrictions (46 – 1500)

⇓ Acquiring the channel. (or) To support CSMA/CD

⇓ Not to assign priority to stat. (or) Give equal chance to all stat. to transmit the data

- If the data is coming from N.L. less than 46B then upto 46B, padding bits are added to support CSMA/CD.
- Max. frame size in IEEE 802.3 = 1518B.

  6 + 6 + 2 + 1500 + 4 = 1518 B
- The max. PDU / Payload = 1500 B.
- This restriction is to give fair & equal chance of all system in the n/w. (No priorities to the systems).

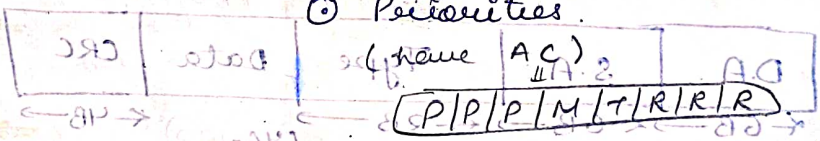


IEEE 802.3

- Non-deterministic channel. (Don't know how many stats transmitt the data)
- No priorities.
- Contention protocol. (collision protocol)
- Manchester encoding.

IEEE 802.5

- Deterministic channel. (only 1 stat transmitt the data at a time).
- Priorities.



- Contentionless protocol. (collision free protocol).
- Uses differential manchester encoding.